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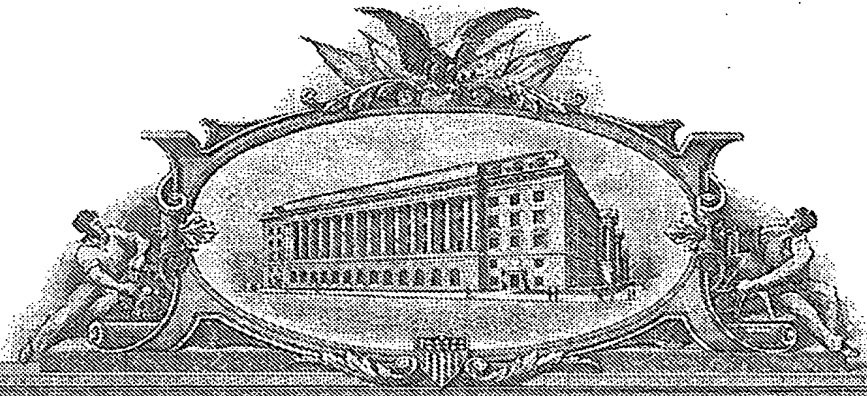
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**TITLE OF THE INVENTION**

MODAFINIL COMPOSITIONS

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## **MODAFINIL COMPOSITIONS**

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## **MODAFINIL COMPOSITIONS**

### **FIELD OF THE INVENTION**

The present invention relates to API-containing compositions, pharmaceutical compositions comprising such APIs, and methods for preparing the same.

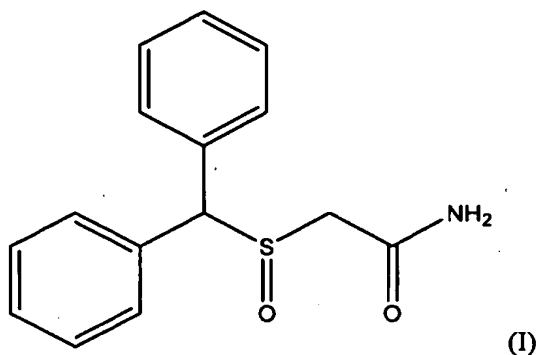
### **BACKGROUND OF THE INVENTION**

Active pharmaceutical ingredients (API or APIs (plural)) in pharmaceutical compositions can be prepared in a variety of different forms. Such APIs can be prepared so as to have a variety of different chemical forms including chemical derivatives or salts. Such APIs can also be prepared to have different physical forms. For example, the APIs may be amorphous, may have different crystalline polymorphs, or may exist in different solvation or hydration states. By varying the form of an API, it is possible to vary the physical properties thereof. For example, crystalline polymorphs typically have different solubilities from one another, such that a more thermodynamically stable polymorph is less soluble than a less thermodynamically stable polymorph. Pharmaceutical polymorphs can also differ in properties such as shelf-life, bioavailability, morphology, vapour pressure, density, colour, and compressibility. Accordingly, variation of the crystalline state of an API is one of many ways in which to modulate the physical properties thereof.

It would be advantageous to have new forms of these APIs that have improved properties, in particular, as oral formulations. Specifically, it is desirable to identify improved forms of APIs that exhibit significantly improved properties including increased aqueous solubility and stability. Further, it is desirable to improve the processability, or preparation of pharmaceutical formulations. For example, needle-like crystal forms or habits of APIs can cause aggregation, even in compositions where the API is mixed with other substances, such that a non-uniform mixture is obtained. It is also desirable to increase the dissolution rate of API-containing pharmaceutical compositions in water, increase the bioavailability of orally-administered compositions, and provide a more rapid onset to therapeutic effect. It is also desirable to have a form of

the API which, when administered to a subject, reaches a peak plasma level faster, has a longer lasting therapeutic plasma concentration, and higher overall exposure when compared to equivalent amounts of the API in its presently-known form.

Modafinil, an API used to treat subjects with narcolepsy, is practically insoluble in water. Modafinil(CAS Registry Number: 68693-11-8) is represented by the structure (I):



It would be advantageous to have new forms of modafinil that have improved properties, in particular, as oral formulations. Specifically, it is desirable to identify improved forms of modafinil that exhibit significantly increased aqueous solubilities and both chemical and form stability. It is also desirable to increase the dissolution rate of API-containing pharmaceutical compositions in water, increase the bioavailability of orally-administered compositions, and provide a more rapid onset to therapeutic effect. It is also desirable to have a form of the API which, when administered to a subject, reaches a peak plasma level faster and/or has a longer lasting plasma concentration and higher overall exposure at high doses when compared to equivalent amounts of the API in its presently-known form.

#### SUMMARY OF THE INVENTION

It has now been found that co-crystals and solvates of modafinil can be obtained, many of which have different properties as compared to the free form of the API.

Accordingly, in a first aspect, the present invention provides a co-crystal of modafinil, wherein the co-crystal former is an ether, thioether, alcohol, thiol, aldehyde, ketone, thioketone, nitrate ester, phosphate ester, thiophosphate ester, ester, thioester, sulfate ester, carboxylic acid, phosphonic acid, phosphinic acid, sulfonic acid, amide, primary amine, secondary amine, ammonia, tertiary amine, sp<sup>2</sup> amine, thiocyanate, cyanamide, oxime, nitrile, diazo, organohalide, nitro, S-heterocyclic ring, thiophene, N-heterocyclic ring, pyrrole, O-heterocyclic ring, furan, epoxide, peroxide, hydroxamic acid, imidazole, or pyridine.

The invention further provides a pharmaceutical composition comprising a co-crystal of modafinil. Typically, the pharmaceutical composition further comprises one or more pharmaceutically-acceptable carriers, diluents or excipients. Pharmaceutical compositions according to the invention are described in further detail below.

In a further aspect, the present invention provides a process for the preparation of a co-crystal of modafinil, which comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (d) isolating co-crystals comprising modafinil and the co-crystal former.

In an embodiment, the co-crystal former has at least one functional group selected from the group consisting of ether, thioether, alcohol, thiol, aldehyde, ketone, thioketone, nitrate ester, phosphate ester, thiophosphate ester, ester, thioester, sulfate ester, carboxylic acid, phosphonic acid, phosphinic acid, sulfonic acid, amide, primary amine, secondary amine, ammonia, tertiary amine, sp<sup>2</sup> amine, thiocyanate, cyanamide, oxime, nitrile, diazo, organohalide, nitro, S-heterocyclic ring, thiophene, N-heterocyclic ring, pyrrole, O-heterocyclic ring, furan, epoxide, peroxide, hydroxamic acid, imidazole, or pyridine.

In a further aspect, the present invention provides a process for increasing the solubility of modafinil in water, simulated gastric fluid (SGF), or simulated intestinal fluid (SIF) for use in a pharmaceutical composition or medicament, which process comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (d) isolating co-crystals comprising the modafinil and the co-crystal former.

In a further aspect, the present invention provides a process for modulating the dissolution of modafinil, whereby the aqueous dissolution rate or the dissolution rate in simulated gastric fluid or in simulated intestinal fluid, or in a solvent or plurality of solvents is increased, which process comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (d) isolating co-crystals comprising the modafinil and the co-crystal former.

In a further aspect, the present invention provides a process for modulating the bioavailability of modafinil, whereby the AUC is increased, the time to  $T_{\max}$  is reduced, the length of time the concentration of modafinil is above  $\frac{1}{2} T_{\max}$  is increased, or  $C_{\max}$  is increased, which process comprises:

- (a) providing modafinil;

- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (d) isolating co-crystals comprising the modafinil and the co-crystal former.

In a further aspect, the present invention provides a process for modulating the dose response of modafinil for use in a pharmaceutical composition or medicament, which process comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (d) isolating co-crystals comprising the modafinil and the co-crystal former.

In a still further aspect the present invention provides a process for improving the stability of modafinil (as compared to a reference form such as its free form), which process comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and

- (d) isolating co-crystals comprising the modafinil and the co-crystal former.

In a still further aspect the present invention provides a process for modifying the morphology of modafinil, which process comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (d) isolating co-crystals comprising the modafinil and the co-crystal former.

In a still further aspect, the present invention therefore provides a process of screening for co-crystal compounds, which comprises:

- (a) providing (i) modafinil and (ii) a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal; and
- (b) screening for co-crystals of modafinil with a co-crystal former by subjecting each combination of modafinil and co-crystal former to a procedure comprising:
  - (i) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
  - (ii) isolating co-crystals comprising the modafinil and the co-crystal former.

An alternative embodiment is drawn to a process of screening for co-crystal compounds, which comprises:

- (a) providing (i) modafinil and (ii) a plurality of different co-crystal formers

compatible with a functional group of modafinil such that each co-crystal former and the modafinil can form a co-crystal; and

(b) screening for co-crystals of modafinil with co-crystal formers by subjecting each combination of modafinil and co-crystal former to a procedure comprising:

- (i) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (ii) isolating co-crystals comprising the modafinil and the co-crystal former.

In a further aspect, the present invention provides a co-crystal composition comprising a co-crystal, wherein said co-crystal comprises modafinil and a co-crystal former. In further embodiments the co-crystal has an improved property as compared to the free form (which includes hydrates and solvates). In further embodiments, the improved property is selected from the group consisting of: increased solubility, increased dissolution, increased bioavailability, increased dose response, or other property described herein.

In another embodiment, the present invention provides a co-crystal comprising modafinil and a co-crystal former selected from the group consisting of: malonic acid, glycolic acid, fumaric acid, tartaric acid, citric acid, succinic acid, gentisic acid, oxalic acid, 1-hydroxy-2-naphthoic acid, lauric acid, orotic acid, and maleic acid.

In further embodiments, the present invention provides the following co-crystals: modafinil:malonic acid, modafinil:glycolic acid, modafinil:maleic acid, modafinil:L-tartaric acid, modafinil:citric acid, modafinil:succinic acid, modafinil:DL-tartaric acid, modafinil:fumaric acid (Form I), modafinil:fumaric acid (Form II), modafinil:gentisic acid, modafinil:oxalic acid, modafinil:1-hydroxy-2-naphthoic acid, R-(-)-modafinil:malonic acid, R-(-)-modafinil:succinic acid, R-(-)-modafinil:citric acid, R-(-)-modafinil:DL-tartaric acid, R-(-)-modafinil:1-hydroxy-2-naphthoic acid, R-(-)-modafinil:lauric acid, R-(-)-modafinil:orotic acid, and R-(-)-modafinil:gentisic acid.

In another embodiment, the present invention provides a novel polymorph of racemic modafinil (form VII).

In another embodiment, the present invention provides the following modafinil solvates: acetic acid, tetrahydrofuran, 1,4-dioxane, methanol, nitromethane, acetone, *o*-xylene, benzene, and toluene.

The processes according to the present invention may each comprise a further step or steps in which the modafinil co-crystal produced thereby is incorporated into a pharmaceutical composition.

In a further embodiment, the present invention provides a novel polymorph of R-(-)-modafinil. In a specific embodiment, the present invention provides Forms I, II, III, IV, and V of R-(-)-modafinil. The present invention also provides a method of making a polymorph of R-(-)-modafinil.

In a further embodiment, the present invention provides a method of making a polymorph of R-(-)-modafinil, comprising:

- (a) providing R-(-)-modafinil;
- (b) crystallizing the polymorph of R-(-)-modafinil from an appropriate solvent.

In a further embodiment, a polymorph of R-(-)-modafinil is crystallized from an organic solvent. In a particular embodiment, the organic solvent is ethanol. In another embodiment, a mixed solvent system is used to crystallize a polymorph of R-(-)-modafinil. Mixed solvent systems can be, for example, ethanol and isopropyl alcohol, or ethyl acetate and ethanol. In a further embodiment, the crystallization in step (b) is completed via thermal recrystallization. In a further embodiment, the crystallization in step (b) is completed via evaporation of the solvent.

In another embodiment, a pharmaceutical composition comprises a modified release profile of one or more of racemic modafinil, R-(-)-modafinil, and S-(+)-modafinil. The modified release profile can comprise, for example, two or more maxima of plasma concentration, such as a dual-release profile.

The invention further provides a medicament comprising a co-crystal of modafinil. Typically, the medicament further comprises one or more pharmaceutically-



acceptable carriers, diluents or excipients. Medicaments according to the invention are described in further detail below.

The processes according to the present invention may each comprise a further step or steps in which the modafinil co-crystal produced thereby is incorporated into a medicament.

In a still further aspect of the invention, a method is provided for treating a subject, preferably a human subject, suffering from excessive daytime sleepiness associated with narcolepsy, multiple sclerosis related fatigue, infertility, eating disorders, attention deficit hyperactivity disorder (ADHD), Parkinson's disease, incontinence, sleep apnea, or myopathies where modafinil is an effective active pharmaceutical for said disorder. The method comprises administering to the subject a therapeutically-effective amount of a co-crystal or a solvate comprising modafinil, or a polymorph of modafinil.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1- PXRD diffractogram of a co-crystal comprising modafinil and malonic acid.

Figure 2- DSC thermogram of a co-crystal comprising modafinil and malonic acid.

Figure 3- TGA thermogram of a co-crystal comprising modafinil and malonic acid.

Figure 4A and 4B- Raman spectrum of a co-crystal comprising modafinil and malonic acid (Figure 4A), and three Raman spectra of modafinil (bottom spectrum), malonic acid (middle spectrum), and a co-crystal comprising modafinil and malonic acid (top spectrum) (Figure 4B).

Figure 5A and 5B- Infrared spectrum of a co-crystal comprising modafinil and malonic acid (Figure 5A), and three Infrared spectra of modafinil (top spectrum), malonic acid (middle spectrum), and a co-crystal comprising modafinil and malonic acid (bottom spectrum) (Figure 5B).

Figure 6- PXRD diffractogram of a co-crystal comprising modafinil and malonic acid.

Figure 7- Packing diagram for modafinil:malonic acid co-crystal.

Figures 8A and 8B- PXRD diffractograms of a co-crystal comprising modafinil and glycolic acid, background removed and as collected, respectively.

Figures 9A and 9B- PXRD diffractograms of a co-crystal comprising modafinil and maleic acid, background removed and as collected, respectively.

Figure 10- PXRD diffractogram of a co-crystal comprising modafinil and L-tartaric acid.

Figure 11- PXRD diffractogram of a co-crystal comprising modafinil and citric acid.

Figures 12A and 12B- PXRD diffractogram of a co-crystal comprising modafinil and succinic acid, background removed and as collected, respectively.

Figure 13- DSC thermogram of a co-crystal comprising modafinil and succinic acid.

Figure 14- Packing diagram of a co-crystal comprising modafinil and succinic acid.

Figure 15- PXRD diffractogram of a co-crystal comprising modafinil and DL-tartaric acid.

Figure 16- PXRD diffractogram of a co-crystal comprising modafinil and fumaric acid (Form I).

Figure 17- Packing diagram of a co-crystal comprising modafinil and fumaric acid (Form I).

Figure 18- PXRD diffractogram of a co-crystal comprising modafinil and fumaric acid (Form II).

Figure 19- PXRD diffractogram of a co-crystal comprising modafinil and gentisic acid.

Figure 20- PXRD diffractogram of a co-crystal comprising modafinil and oxalic acid.

Figure 21- PXRD diffractogram of a co-crystal comprising modafinil and 1-hydroxy-2-naphthoic acid.

Figure 22- PXRD diffractogram of a co-crystal comprising R-(-)-modafinil and malonic acid.

Figure 23- DSC thermogram of a co-crystal comprising R-(-)-modafinil and malonic acid.

Figure 24- PXRD diffractogram of a co-crystal comprising R-(-)-modafinil and succinic acid.

Figure 25- DSC thermogram of a co-crystal comprising R-(-)-modafinil and succinic acid.

Figure 26- PXRD diffractogram of a co-crystal comprising R-(-)-modafinil and citric acid.

Figure 27- DSC thermogram of a co-crystal comprising R-(-)-modafinil and citric acid.

Figure 28- PXRD diffractogram of a co-crystal comprising R-(-)-modafinil and DL-tartaric acid.

Figure 29- DSC thermogram of a co-crystal comprising R-(-)-modafinil and DL-tartaric acid.

Figure 30- PXRD diffractogram of a co-crystal comprising R-(-)-modafinil and 1-hydroxy-2-naphthoic acid.

Figure 31- DSC thermogram of a co-crystal comprising R-(-)-modafinil and 1-hydroxy-2-naphthoic acid.

Figure 32- PXRD diffractogram of a co-crystal comprising R-(-)-modafinil and lauric acid (bottom pattern).

Figure 33- DSC thermogram of a co-crystal comprising R-(-)-modafinil and lauric acid.

Figure 34- PXRD diffractogram of a co-crystal comprising R-(-)-modafinil and orotic acid.

Figure 35- DSC thermogram of a co-crystal comprising R-(-)-modafinil and orotic acid.

Figure 36- PXRD diffractogram of a solvate comprising modafinil and acetic acid.

Figure 37- TGA thermogram of a solvate comprising modafinil and acetic acid.

Figure 38- DSC thermogram of a solvate comprising modafinil and acetic acid.

Figure 39- Raman spectrum of a solvate comprising modafinil and acetic acid.

Figure 40- PXRD diffractogram of a solvate comprising modafinil and tetrahydrofuran.

Figure 41- PXRD diffractogram of a solvate comprising modafinil and 1,4-dioxane.

Figure 42- PXRD diffractogram of a solvate comprising modafinil and methanol.

Figure 43- TGA thermogram of a solvate comprising modafinil and methanol.

Figure 44- DSC thermogram of a solvate comprising modafinil and methanol.

Figure 45- PXRD diffractogram of a solvate comprising modafinil and nitromethane.

Figure 46- PXRD diffractogram of a solvate comprising modafinil and acetone.

Figure 47- PXRD diffractogram of a possible solvate comprising modafinil and acetone.

Figure 48- PXRD diffractogram of a possible solvate comprising modafinil and 1,2-dichloroethane.

Figure 49- PXRD diffractogram of a polymorph of modafinil (Form VII).

Figure 50- Stability plot of modafinil:malonic acid co-crystal over a 26 week period.

Figure 51- Closer view of stability plot of modafinil:malonic acid co-crystal over a 26 week period.

Figure 52- PXRD diffractogram comparison of modafinil:malonic acid co-crystal after several environmental conditions are endured.

Figure 53- Dissolution profile of several formulations of modafinil free form and modafinil:malonic acid.

Figure 54- In Vitro dissolution profile of modafinil:malonic acid co-crystal in SGF and SIF.

Figure 55- In Vitro dissolution profile of modafinil:malonic acid co-crystal in HCl.

Figure 56- DVS plot of modafinil:malonic acid co-crystal.

Figure 57- Pharmacokinetics of modafinil:malonic acid co-crystal in dogs.

Figure 58A- PXRD diffractogram of polymorphs of R-(-)-modafinil (Forms I and II).

Figure 58B- DSC thermogram of polymorphs of R-(-)-modafinil (Forms I and II).

Figure 59A- PXRD diffractogram of a polymorph of R-(-)-modafinil (Form III).

Figure 59B- DSC thermogram of a polymorph of R-(-)-modafinil (Form III).

Figure 59C- PXRD diffractogram of a polymorph of R-(-)-modafinil (Form III).

Figure 60A- PXRD diffractogram of a polymorph of R-(-)-modafinil (Form IV).

Figure 60B- DSC thermogram of a polymorph of R-(-)-modafinil (Form IV).

Figure 60C- PXRD diffractogram of a polymorph of R-(-)-modafinil (Form IV).

Figure 61A- PXRD diffractogram of a polymorph of R-(-)-modafinil (Form V).

Figure 61B- PXRD diffractogram of a polymorph of R-(-)-modafinil (Form V).

Figure 62- PXRD diffractogram of a co-crystal comprising R-(-)-modafinil and gentisic acid.

Figure 63- Packing diagram of acetone channel solvate of modafinil.

Figure 64- Additional packing diagram of acetone channel solvate of modafinil.

Figure 65- PXRD diffractogram of *o*-xylene solvate.

Figure 66- Raman spectrum of *o*-xylene solvate (middle spectrum).

Figure 67- TGA thermogram of *o*-xylene solvate.

Figure 68- DSC thermogram of *o*-xylene solvate.

Figure 69- PXRD diffractogram of benzene solvate.

Figure 70- Raman spectrum of benzene solvate (middle spectrum).

Figure 71- TGA thermogram of benzene solvate.

Figure 72- DSC thermogram of benzene solvate.

Figure 73- PXRD diffractogram of toluene solvate.

Figure 74- Raman spectrum of toluene solvate (middle spectrum).

Figure 75- TGA thermogram of toluene solvate.

Figure 76- DSC thermogram of toluene solvate.

### DETAILED DESCRIPTION OF THE INVENTION

The structure of modafinil includes a stereocenter and, therefore, can exist as a racemate, one of two pure isomers, or any ratio of the two isomeric pairs. The chemical name of racemic modafinil is  $(\pm)$ -2-[(Diphenylmethyl) sulfinyl]acetamide. The isomeric pairs of racemic modafinil are R-(-)-2-[(Diphenylmethyl) sulfinyl]acetamide or R-(-)-modafinil and S-(+)-2-[(Diphenylmethyl) sulfinyl]acetamide or S-(+)-modafinil.

The term "co-crystal" as used herein means a crystalline material comprised of two or more unique solids at room temperature (22 degrees C), each containing distinctive physical characteristics, such as structure, melting point, and heats of fusion, with the exception that, if specifically stated, the API may be a liquid at room temperature. The co-crystals of the present invention comprise a co-crystal former H-bonded to modafinil or a derivative thereof. The co-crystal former may be H-bonded directly to modafinil or may be H-bonded to an additional molecule which is bound to modafinil. The additional molecule may be H-bonded to modafinil or bound ionically or covalently to modafinil. The additional molecule could also be a different API. Solvates of modafinil compounds that do not further comprise a co-crystal former are not co-crystals according to the present invention. The co-crystals may however, include one or more solvate molecules in the crystalline lattice. That is, a solvate of co-crystal, or a co-crystal further comprising a solvent or compound that is a liquid at room temperature, is a co-crystal according to the present invention, but crystalline material comprised of only modafinil and one or more liquids (at room temperature) are not co-crystals for purposes of the present invention. Other modes of molecular recognition may also be present

including, pi-stacking, guest-host complexation and van der Waals interactions. Of the interactions listed above, hydrogen-bonding is the dominant interaction in the formation of the co-crystal, (and a required interaction according to the present invention) whereby a non-covalent bond is formed between a hydrogen bond donor of one of the moieties and a hydrogen bond acceptor of the other. Hydrogen bonding can result in several different intermolecular configurations. For example, hydrogen bonds can result in the formation of dimers, linear chains, or cyclic structures. These configurations can further include extended (two-dimensional) hydrogen bond networks and isolated triads. An alternative embodiment provides for a co-crystal wherein the co-crystal former is a second API. In another embodiment, the co-crystal former is not an API.

For purposes of the present invention, the chemical and physical properties of modafinil in the form of a co-crystal may be compared to a reference compound that is modafinil in a different form. The reference compound may be specified as a free form, or more specifically, an anhydrate or hydrate of a free form, or more specifically, for example, a hemihydrate, monohydrate, dihydrate, trihydrate, quadrahydrate, pentahydrate; or a solvate of a free form. For example, the reference compound for modafinil in free form co-crystallized with a co-crystal former can be modafinil in free form. The reference compound may also be specified as crystalline or amorphous. The reference compound may also be specified as the most stable polymorph known of the specified form of the reference compound.

The ratio of modafinil to co-crystal former may be stoichiometric or non-stoichiometric according to the present invention. Non-limiting examples such as, 1:1, 1:1.5, 1.5:1, 1:2, and 2:1 ratios of modafinil:co-crystal former are acceptable. In addition, co-crystals with vacancies within the crystalline lattice are included in the present invention. For example, a co-crystal with less than or about 0.01, 0.1, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20 percent vacancies within the crystalline lattice are included in the present invention. The vacancies can be due to missing modafinil molecules or missing co-crystal former molecules from the crystalline lattice, or both.

It has surprisingly been found that when modafinil and a selected co-crystal former are allowed to form co-crystals, the resulting co-crystals often give rise to improved properties of modafinil, as compared to modafinil in the free form, particularly with respect to: solubility, dissolution, bioavailability, stability,  $C_{max}$ ,  $T_{max}$ , processability (including compressibility), longer lasting therapeutic plasma concentration, etc. For example, a co-crystal form of modafinil is particularly advantageous due to the low solubility of modafinil in water. Additionally, the co-crystal properties conferred upon modafinil are also useful because the bioavailability of modafinil can be improved and the plasma concentration and/or serum concentration of modafinil can be improved. This is particularly advantageous for orally-administrable formulations. Moreover, the dose response of modafinil can be improved, for example by increasing the maximum attainable response and/or increasing the potency of modafinil by increasing the biological activity per dosing equivalent.

Accordingly, in a first aspect, the present invention provides a pharmaceutical composition (or medicament) comprising a co-crystal of modafinil and a co-crystal former, such that the modafinil and the co-crystal former are capable of co-crystallizing from a solution phase under crystallization conditions or from the solid-state, for example, through grinding or heating. In another aspect, the co-crystal former which has at least one functional group selected from the group consisting of ether, thioether, alcohol, thiol, aldehyde, ketone, thioketone, nitrate ester, phosphate ester, thiophosphate ester, ester, thioester, sulfate ester, carboxylic acid, phosphonic acid, phosphinic acid, sulfonic acid, amide, primary amine, secondary amine, ammonia, tertiary amine, sp<sup>2</sup> amine, thiocyanate, cyanamide, oxime, nitrile, diazo, organohalide, nitro, S-heterocyclic ring, thiophene, N-heterocyclic ring, pyrrole, O-heterocyclic ring, furan, epoxide, peroxide, hydroxamic acid, imidazole, and pyridine, or a functional group in a Table herein, such that the modafinil and co-crystal former are capable of co-crystallizing from a solution phase under crystallization conditions.

In another embodiment, the use of an excess (more than 1 molar equivalent for a 1:1 co-crystal) of a co-crystal former can be used to drive the formation of stoichiometric co-crystals. For example, co-crystals with stoichiometries of 1:1, 2:1, or 1:2 can be produced by adding co-crystal former in an amount that is 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20,

25, 50, 75, 100 times or more than the stoichiometric amount for a given co-crystal. Such an excessive use of a co-crystal former to form a co-crystal can be employed in solution or when grinding modafinil and a co-crystal former to cause co-crystal formation.

In another embodiment of the present invention, a modafinil co-crystal further comprises a co-crystal former which is hydrogen bonded via a preferred interaction between two or more functional groups. For example, modafinil and malonic acid co-crystallize through the interaction of a carboxylic acid functional group of the co-crystal former with sulfoxide and amide functional groups of modafinil.

In another embodiment of the present invention, the co-crystal comprises modafinil wherein the modafinil forms a dimeric primary amide structure via hydrogen bonds with an  $R^2_2$  (8) motif. In such a structure, the  $NH_2$  moiety can also participate in a hydrogen bond with a donor or an acceptor moiety from, for example, a co-crystal former or an additional (third) molecule, and the  $C=O$  moiety can participate in a hydrogen bond with a donor moiety from the co-crystal former or the additional molecule. In a further embodiment, the dimeric primary amide structure further comprises one, two, three, or four hydrogen bond donors. In a further embodiment, the dimeric primary amide structure further comprises one or two hydrogen bond acceptors. In a further embodiment, the dimeric primary amide structure further comprises a combination of hydrogen bond donors and acceptors. For example, the dimeric primary amide structure can further comprise one hydrogen bond donor and one hydrogen bond acceptor, one hydrogen bond donor and two hydrogen bond acceptors, two hydrogen bond donors and one hydrogen bond acceptor, two hydrogen bond donors and two hydrogen bond acceptors, or three hydrogen bond donors and one hydrogen bond acceptor.

The co-crystals of the present invention are formed where modafinil and the co-crystal former are bonded together through hydrogen bonds. Other non-covalent interactions, including pi-stacking and van der Waals interactions, may also be present.

In one embodiment, the co-crystal former is selected from the co-crystal formers of Table I and Table II. In other embodiments, the co-crystal former of Table I is specified as a Class 1, Class 2, or Class 3 co-crystal former (see column labeled "class" Table I). Table I lists multiple  $pK_a$  values for co-crystal formers having multiple



functionalities. It is readily apparent to one skilled in the art the particular functional group corresponding to a particular  $pK_a$  value.

In another embodiment the particular functional group of a co-crystal former interacting with modafinil is specified (see for example Table I, columns labeled "Functionality" and "Molecular Structure" and the column of Table II labeled "Co-Crystal Former Functional Group").

In another embodiment, the co-crystal comprises more than one co-crystal former. For example, two, three, four, five, or more co-crystal formers can be incorporated in a co-crystal with modafinil. Co-crystals which comprise two or more co-crystal formers and an API are bound together via hydrogen bonds. In one embodiment, incorporated co-crystal formers are hydrogen bonded to modafinil molecules. In another embodiment, co-crystal formers are hydrogen bonded to either the modafinil molecules or the incorporated co-crystal formers.

In each process according to the invention, there is a need to contact modafinil with the co-crystal former. This may involve grinding the two solids together or melting one or both components and allowing them to recrystallize. This may also involve either solubilizing modafinil and adding the co-crystal former, or solubilizing the co-crystal former and adding modafinil. Crystallization conditions are applied to modafinil and the co-crystal former. This may entail altering a property of the solution, such as pH or temperature and may require concentration of the solute, usually by removal of the solvent, typically by drying the solution. Solvent removal results in the concentration of both modafinil and the co-crystal former increasing over time so as to facilitate crystallization. For example, evaporation, cooling, or the addition of an antisolvent may be used to crystallize co-crystals. In another embodiment, a slurry comprising modafinil and a co-crystal former is used to form co-crystals. Once the solid phase comprising any crystals is formed, this may be tested as described herein.

The co-crystals obtained as a result of such process steps may be readily incorporated into a pharmaceutical composition (or medicament) by conventional means. Pharmaceutical compositions and medicaments in general are discussed in further detail below and may further comprise a pharmaceutically-acceptable diluent, excipient or carrier.

In a further aspect, the present invention provides a process for the preparation of a co-crystal of modafinil, which comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (d) isolating co-crystals comprising modafinil and the co-crystal former.

In an embodiment, the co-crystal former has at least one functional group selected from the group consisting of ether, thioether, alcohol, thiol, aldehyde, ketone, thioketone, nitrate ester, phosphate ester, thiophosphate ester, ester, thioester, sulfate ester, carboxylic acid, phosphonic acid, phosphinic acid, sulfonic acid, amide, primary amine, secondary amine, ammonia, tertiary amine, sp<sup>2</sup> amine, thiocyanate, cyanamide, oxime, nitrile, diazo, organohalide, nitro, S-heterocyclic ring, thiophene, N-heterocyclic ring, pyrrole, O-heterocyclic ring, furan, epoxide, peroxide, hydroxamic acid, imidazole, or pyridine.

In a further aspect, the present invention provides a process for the production of a pharmaceutical composition or medicament, which process comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions;
- (d) isolating co-crystals formed thereby; and
- (e) incorporating the co-crystals into a pharmaceutical composition or medicament.

In another embodiment, a process for the formation of co-crystals includes a meta-stable form of modafinil, the co-crystal former, or both. A meta-stable form can be

for example, but not limited to, a polymorph, solvate, or hydrate of modafinil or the co-crystal former. While not bound by theory, the incorporation of a meta-stable form may facilitate co-crystal formation via increasing the thermodynamic driving force.

Assaying the solid phase for the presence of co-crystals of modafinil and the co-crystal former may be carried out by conventional methods known in the art. For example, it is convenient and routine to use powder X-ray diffraction techniques to assess the presence of co-crystals. This may be affected by comparing the diffractograms of modafinil, the crystal former and putative co-crystals in order to establish whether or not true co-crystals had been formed. Other techniques, used in an analogous fashion, include differential scanning calorimetry (DSC), thermogravimetric analysis (TGA) and Raman spectroscopy. Single crystal X-ray diffraction is especially useful in identifying co-crystal structures.

In a further aspect, the present invention therefore provides a process of screening for co-crystal compounds, which comprises:

(a) providing (i) modafinil and (ii) a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal; and

(b) screening for co-crystals of the modafinil with the co-crystal former by subjecting each combination of modafinil and co-crystal former to a procedure comprising:

(i) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions so as to form a solid phase; and

(ii) isolating co-crystals comprising the modafinil and the co-crystal former.

An alternative embodiment is drawn to a process of screening for co-crystal compounds, which comprises:

(a) providing (i) modafinil and (ii) a plurality of different co-crystal formers compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal; and

(b) screening for co-crystals of the modafinil with the co-crystal formers by subjecting each combination of the modafinil and the co-crystal formers to a procedure comprising:

(i) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with each co-crystal former under crystallization conditions so as to form a solid phase; and

(ii) isolating co-crystals comprising the modafinil and the co-crystal former.

The present invention includes several co-crystals comprising modafinil and a carboxylic acid co-crystal former. Some examples include modafinil co-crystals comprising malonic acid, tartaric acid (L- and DL-), succinic acid, citric acid, fumaric acid, gentisic acid, oxalic acid, and 1-hydroxy-2-naphthoic acid. These examples represent mono-, di- and tri-carboxylic acid co-crystal formers. Other acids, including carboxylic acids, may be used as co-crystal formers with modafinil including, but not limited to, palmitic acid, lauric acid, orotic acid, and adipic acid etc. These co-crystal formers may comprise one, two, three, or more carboxylic acid functional groups. Co-crystal formers can also include non-carboxylic acid molecules such as, but not limited to, urea, saccharin, and caffeine.

In another embodiment, a co-crystal comprises modafinil and a carboxylic acid as a co-crystal former. In another embodiment, the carboxylic acid co-crystal former has one, two, three, or more carboxylic acid functional groups.

Several co-crystals may exhibit one or more particular interactions between modafinil and a carboxylic acid co-crystal former. For example, a carboxylic acid functional group can interact with the primary amide and/or the S=O functional group of modafinil via a hydrogen bond. In another embodiment, a carboxylic acid functional group from the co-crystal former interacts with the primary amide functional group or the S=O functional group of modafinil via a hydrogen bond. In another embodiment, a

carboxylic acid functional group from the co-crystal former interacts with the periphery of the amide dimer of modafinil via a hydrogen bond. In another embodiment, a carboxylic acid functional group from the co-crystal former interacts with the amide dimer and the S=O functional group of modafinil via a hydrogen bond. In another embodiment, a carboxylic acid functional group from the co-crystal former interacts with two amide dimers of modafinil via a hydrogen bond.

Modafinil and some co-crystal formers of the present invention have one or more chiral centers and may exist in a variety of stereoisomeric configurations. As a consequence of these chiral centers, modafinil and several co-crystal formers of the present invention occur as racemates, mixtures of enantiomers and as individual enantiomers, as well as diastereomers and mixtures of diastereomers. All such racemates, enantiomers, and diastereomers are within the scope of the present invention including, for example, *cis*- and *trans*-isomers, R- and S-enantiomers, and (D)- and (L)-isomers. Co-crystals of the present invention can include isomeric forms of either modafinil or the co-crystal former or both. Isomeric forms of modafinil and co-crystal formers include, but are not limited to, stereoisomers such as enantiomers and diastereomers. In one embodiment, a co-crystal can comprise racemic modafinil and/or a co-crystal former. In another embodiment, a co-crystal can comprise enantiomerically pure R- or S-modafinil and/or a co-crystal former. In another embodiment, a co-crystal of the present invention can comprise modafinil or a co-crystal former with an enantiomeric excess of about 1 percent, 2 percent, 3 percent, 4 percent, 5 percent, 10 percent, 15 percent, 20 percent, 25 percent, 30 percent, 35 percent, 40 percent, 45 percent, 50 percent, 55 percent, 60 percent, 65 percent, 70 percent, 75 percent, 80 percent, 85 percent, 90 percent, 95 percent, 96 percent, 97 percent, 98 percent, 99 percent, greater than 99 percent, or any intermediate value. Several non-limiting examples of stereoisomeric co-crystal formers include tartaric acid and malic acid.

Co-crystals comprising enantiomerically pure components (e.g., modafinil or co-crystal former) can give rise to chemical and/or physical properties which are modulated with respect to those of the corresponding co-crystal comprising a racemic component. For example, the modafinil:malonic acid co-crystal from Example 1 comprises racemic modafinil. Enantiomerically pure R-(-)-modafinil:malonic acid is included in the scope

of the invention. Likewise, enantiomerically pure S-(+)-modafinil:malonic acid is included in the scope of the invention. A co-crystal comprising an enantiomerically pure component can give rise to a modulation of, for example, activity, bioavailability, or solubility, with respect to the corresponding co-crystal comprising a racemic component. As an example, the co-crystal R-(-)-modafinil:malonic acid can have modulated properties as compared to the racemic modafinil:malonic acid co-crystal.

As used herein and unless otherwise specified, the term "racemic co-crystal" refers to a co-crystal which is comprised of an equimolar mixture of the enantiomers of modafinil, the co-crystal former, or both. For example, a co-crystal comprising modafinil and a non-stereoisomeric co-crystal former is a "racemic co-crystal" only when there is present an equimolar mixture of the modafinil enantiomers. Similarly, a co-crystal comprising modafinil and a stereoisomeric co-crystal former is a "racemic co-crystal" only when there is present an equimolar mixture of the modafinil enantiomers and of the co-crystal former enantiomers.

As used herein and unless otherwise specified, the term "enantiomerically pure co-crystal" refers to a co-crystal which is comprised of modafinil and a stereoisomeric or non-stereoisomeric co-crystal former where the enantiomeric excess of the stereoisomeric species is greater than or equal to about 90 percent *ee* (enantiomeric excess).

In another embodiment, the present invention includes a pharmaceutical composition or medicament comprising a co-crystal with enantiomerically pure modafinil and/or co-crystal former wherein the bioavailability is modulated with respect to the racemic co-crystal. In another embodiment, the present invention includes a pharmaceutical composition or medicament comprising a co-crystal with enantiomerically pure modafinil and/or co-crystal former wherein the activity is modulated with respect to the racemic co-crystal. In another embodiment, the present invention includes a pharmaceutical composition or medicament comprising a co-crystal with enantiomerically pure modafinil and/or co-crystal former wherein the solubility is modulated with respect to the racemic co-crystal.

As used herein and unless otherwise specified, the term "enantiomerically pure" includes a composition which is substantially enantiomerically pure and includes, for

example, a composition with greater than or equal to about 90, 91, 92, 93, 94, 95, 96, 97, 98, or 99 percent enantiomeric excess.

As used herein, the term "modafinil" includes the racemate, other mixtures of R- and S-isomers, and single enantiomers, but may be specifically set forth as the racemate, R-isomer, S-isomer, or any mixture of both R- and S-isomers.

In another embodiment, a pharmaceutical composition or medicament can be formulated to contain modafinil in co-crystal form as micronized or nano-sized particles. More specifically, another embodiment couples the processing of pure modafinil to a co-crystal form with the process of making a controlled particle size for manipulation into a pharmaceutical dosage form. This embodiment combines two processing steps into a single step via techniques such as, but not limited to, grinding, alloying, or sintering (i.e., heating a powder mix). The coupling of these processes overcomes a serious limitation of having to isolate and store the bulk drug that is required for a formulation, which in some cases can be difficult to isolate (e.g., amorphous, chemically or physically unstable).

#### Solubility Modulation

In a further aspect, the present invention provides a process for increasing the solubility of modafinil in water, simulated gastric fluid (SGF), or simulated intestinal fluid (SIF) for use in a pharmaceutical composition or medicament, which process comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (d) isolating co-crystals comprising the modafinil and the co-crystal former.

In one embodiment, the solubility of modafinil is modulated such that the aqueous solubility (mg/mL) is increased by at least 1.1, 1.2, 1.3, 1.5, 2.0, 5.0, 10.0, 20.0, 25.0, 50.0, 75.0, or 100.0 times or more than the free form. Solubility of modafinil may be measured by any conventional means such as chromatography (e.g., HPLC) or spectroscopic determination of the amount of modafinil in a saturated solution, such as UV-spectroscopy, IR-spectroscopy, Raman spectroscopy, quantitative mass spectroscopy, or gas chromatography.

In another embodiment, the compositions or medicaments including co-crystals, solvates, and polymorphs of the present invention can be compared with free form modafinil as found in PROVIGIL® (Cephalon, Inc.). (See US Reissued Patent No. RE37,516) For example, the bioavailability of a composition or medicament of the present invention can be compared with that of PROVIGIL. As embodiments of the present invention, solubility can be increased 2, 3, 4, 5, 7, 10, 15, 20, 25, 50, 75, or 100 times by making a co-crystal of the reference form (e.g., crystalline or amorphous free form, hydrate or solvate). Further aqueous solubility can be measured in simulated gastric fluid (SGF) or simulated intestinal fluid (SIF) rather than water. SGF (non-diluted) of the present invention is made by combining 1 g/L Triton X-100 and 2 g/L NaCl in water and adjusting the pH with 20 mM HCl to obtain a solution with a final pH=1.7 SIF is 0.68% monobasic potassium phosphate, 1% pancreatin, and sodium hydroxide where the pH of the final solution is 7.5. The pH of the solvent used may also be specified as 1, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, or 12, or any pH in between successive values.

Examples of embodiments includes: co-crystal compositions with an aqueous solubility, at 37 degrees C and a pH of 7.0, that is increased at least 5 fold over the reference form, co-crystal compositions with a solubility in SGF that is increased at least 5 fold over the reference form, co-crystal compositions with a solubility in SIF that is increased at least 5 fold over the reference form.

#### Dissolution Modulation



In another aspect of the present invention, the dissolution profile of modafinil is modulated whereby the aqueous dissolution rate or the dissolution rate in simulated gastric fluid or in simulated intestinal fluid, or in a solvent or plurality of solvents is increased. Dissolution rate is the rate at which API solids dissolve in a dissolution medium. For APIs whose absorption rates are faster than the dissolution rates (e.g., steroids), the rate-limiting step in the absorption process is often the dissolution rate. Because of a limited residence time at the absorption site, APIs that are not dissolved before they are removed from intestinal absorption site are considered useless. Therefore, the rate of dissolution has a major impact on the performance of APIs that are poorly soluble. Because of this factor, the dissolution rate of APIs in solid dosage forms is an important, routine, quality control parameter used in the API manufacturing process.

$$\text{Dissolution rate} = KS(C_s - C)$$

where K is dissolution rate constant, S is the surface area,  $C_s$  is the apparent solubility, and C is the concentration of API in the dissolution medium.

For rapid API absorption,  $C_s - C$  is approximately equal to  $C_s$

The dissolution rate of modafinil may be measured by conventional means known in the art.

The increase in the dissolution rate of a co-crystal, as compared to the reference form (e.g., free form), may be specified, such as by 10, 20, 30, 40, 50, 60, 70, 80, 90, or 100%, or by 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 40, 50, 75, 100, 125, 150, 175, 200, 250, 300, 350, 400, 500, 1000, 10,000, or 100,000 fold greater than the reference form (e.g., free form) in the same solution. Conditions under which the dissolution rate is measured are the same as discussed above. The increase in dissolution may be further specified by the time the composition remains supersaturated before reaching equilibrium solubility.

In a further aspect, the present invention provides a process for modulating the dissolution of modafinil, whereby the aqueous dissolution rate or the dissolution rate in simulated gastric fluid or in simulated intestinal fluid, or in a solvent or plurality of solvents is increased, which process comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (d) isolating co-crystals comprising the modafinil and the co-crystal former.

Examples of above embodiments include: co-crystal compositions with a dissolution rate in aqueous solution, at 37 degrees C and a pH of 7.0, that is increased at least 5 fold over the reference form, co-crystal compositions with a dissolution rate in SGF that is increased at least 5 fold over the reference form, co-crystal compositions with a dissolution rate in SIF that is increased at least 5 fold over the reference form.

#### Bioavailability Modulation

The methods of the present invention are used to make a pharmaceutical modafinil formulation with greater solubility, dissolution, and bioavailability. Bioavailability can be improved via an increase in AUC, reduced time to  $T_{max}$ , (the time to reach peak blood serum levels), or increased  $C_{max}$ . The present invention can result in higher plasma concentrations of modafinil when compared to the free form (reference form).

AUC is the area under the plot of plasma concentration of API (not logarithm of the concentration) against time after API administration. The area is conveniently determined by the "trapezoidal rule": The data points are connected by straight line segments, perpendiculars are erected from the abscissa to each data point, and the sum of the areas of the triangles and trapezoids so constructed is computed. When the last measured concentration ( $C_n$ , at time  $t_n$ ) is not zero, the AUC from  $t_n$  to infinite time is estimated by  $C_n/k_{el}$ .

The AUC is of particular use in estimating bioavailability of APIs, and in estimating total clearance of APIs ( $Cl_T$ ). Following single intravenous doses,  $AUC =$

$D/Cl_T$ , for single compartment systems obeying first-order elimination kinetics, where  $D$  is the dose; alternatively,  $AUC = C_0/k_{el}$ , where  $k_{el}$  is the API elimination rate constant. With routes other than the intravenous,  $AUC = F \cdot D/Cl_T$ , where  $F$  is the absolute bioavailability of the API.

In a further aspect, the present invention provides a process for modulating the bioavailability of modafinil, whereby the AUC is increased, the time to  $T_{max}$  is reduced, the length of time the concentration of modafinil is above  $\frac{1}{2} T_{max}$  is increased, or  $C_{max}$  is increased, which process comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (d) isolating co-crystals comprising the modafinil and the co-crystal former.

Examples of the above embodiments include: co-crystal compositions with a time to  $T_{max}$  that is increased by at least 5% as compared to the reference form, co-crystal compositions with a time to  $T_{max}$  that is increased by at least 10% over the reference form, co-crystal compositions with a time to  $T_{max}$  that is increased by at least 15% over the reference form, co-crystal compositions with a time to  $T_{max}$  that is increased by at least 20% over the reference form, co-crystal compositions with a  $T_{max}$  that is increased by at least 25% over the reference form, co-crystal compositions with a  $T_{max}$  that is increased by at least 30% over the reference form, co-crystal compositions with a  $T_{max}$  that is increased by at least 35% over the reference form, co-crystal compositions with a  $T_{max}$  that is increased by at least 40% over the reference form, co-crystal compositions with an AUC that is increased by at least 5% over the reference form, co-crystal compositions with an AUC that is increased by at least 10% over the reference form, co-crystal compositions with an AUC that is increased by at least 15% over the reference form, co-crystal compositions with an AUC that is increased by at least 20% over the reference form, co-crystal compositions with an AUC that is increased by at least 25%

over the reference form, co-crystal compositions with an AUC that is increased by at least 30% over the reference form, co-crystal compositions with an AUC that is increased by at least 35% over the reference form, co-crystal compositions with an AUC that is increased by at least 40% over the reference form. Other examples include wherein the reference form is crystalline, wherein the reference form is amorphous, or wherein the reference form is an anhydrous crystal of modafinil.

#### Dose Response Modulation

In a further aspect, the present invention provides a process for modulating the dose response of modafinil for use in a pharmaceutical composition or medicament, which process comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (d) isolating co-crystals comprising the modafinil and the co-crystal former.

Dose response is the quantitative relationship between the magnitude of response and the dose inducing the response and may be measured by conventional means known in the art. The curve relating effect (as the dependent variable) to dose (as the independent variable) for an API-cell system is the "dose-response curve". Typically, the dose-response curve is the measured response to an API plotted against the dose of the API (mg/kg) given. The dose response curve can also be a curve of AUC against the dose of the API given.

In an embodiment of the present invention, a co-crystal of the present invention has an increased dose response curve or a more linear dose response curve than the corresponding reference compound.

#### Increased Stability

In a still further aspect the present invention provides a process for improving the stability of modafinil (as compared to a reference form such as its free form), which process comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (d) isolating co-crystals comprising the modafinil and the co-crystal former.

In a preferred embodiment, the compositions of the present invention, including modafinil co-crystals, solvates, and formulations comprising modafinil, are suitably stable for pharmaceutical use. Preferably, modafinil or formulations thereof, of the present invention, are stable such that when stored at 30 degrees C for 2 years, less than 0.2 % of any one degradant is formed. The term degradant refers herein to product(s) of a single type of chemical reaction. For example, if a hydrolysis event occurs that cleaves a molecule into two products, for the purpose of the present invention, it would be considered a single degradant. More preferably, when stored at 40 degrees C for 2 years, less than 0.2 % of any one degradant is formed. Alternatively, when stored at 30 degrees C for 3 months, less than 0.2 % or 0.15 %, or 0.1 % of any one degradant is formed, or when stored at 40 degrees C for 3 months, less than 0.2 % or 0.15 %, or 0.1 % of any one degradant is formed. Further alternatively, when stored at 60 degrees C for 4 weeks, less than 0.2 % or 0.15 %, or 0.1 % of any one degradant is formed. The relative humidity (RH) may be specified as ambient RH, 75 % RH, or as any single integer between 1 to 99

% RH. In another embodiment, a single dose of the present invention comprises less than 0.5 %, 0.2 %, or 0.1 % degradants upon administration to a subject.

#### Morphology Modulation

In a still further aspect the present invention provides a process for modifying the morphology of modafinil, which process comprises:

- (a) providing modafinil;
- (b) providing a co-crystal former compatible with a functional group of modafinil such that the co-crystal former and the modafinil can form a co-crystal;
- (c) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (d) isolating co-crystals comprising the modafinil and the co-crystal former.

In an embodiment the co-crystal comprises or consists of modafinil and a co-crystal former wherein the interaction between the two, e.g., H-bonding, occurs between the amino group of modafinil and a co-crystal former with a corresponding interacting group of Table III. In a further embodiment, the co-crystal comprises modafinil and a co-crystal former of Table I or II. In an aspect of the invention, only co-crystals having an H-bond acceptor on the first molecule and an H-bond donor on the second molecule, where the first and second molecules are either co-crystal former and modafinil respectively, or modafinil and co-crystal former respectively, are included in the present invention.

A co-crystal can comprise more than two chemical entities within its co-crystalline structure. For example, a co-crystal can further comprise a solvent molecule, a water molecule, a salt, etc. In addition, a co-crystal can comprise an API and two or more co-crystal formers, a co-crystal former and two or more APIs, two or more APIs, or two or more co-crystal formers.

As defined herein, a ternary co-crystal is a co-crystal which comprises three distinct chemical entities in a stoichiometric ratio, where each is a solid at room

temperature (with the exception that the API may be a liquid at room temperature). Specifically, a ternary co-crystal comprises three distinct chemical entities such as API:co-crystal former(1):co-crystal former(2), where the ratio of components can be, for example, but not limited to, 1:1:1, 2:1:1, 2:1:2, 2:1:0.5, 2:2:1, etc. Ternary co-crystals can also comprise other combinations of components such as, but not limited to, API(1):API(2):co-crystal former, API(1):API(2):API(3), and co-crystal former(1):co-crystal former(2):co-crystal former(3).

In another embodiment, the present invention provides a co-crystal comprising modafinil and a co-crystal former selected from the group consisting of: malonic acid, glycolic acid, fumaric acid, tartaric acid, citric acid, succinic acid, gentisic acid, oxalic acid, 1-hydroxy-2-naphthoic acid, lauric acid, orotic acid, and maleic acid.

In further embodiments, the present invention provides the following co-crystals: modafinil:malonic acid, modafinil:glycolic acid, modafinil:maleic acid, modafinil:L-tartaric acid, modafinil:citric acid, modafinil:succinic acid, modafinil:DL-tartaric acid, modafinil:fumaric acid (Form I), modafinil:fumaric acid (Form II), modafinil:gentisic acid, modafinil:oxalic acid, modafinil:1-hydroxy-2-naphthoic acid, R-(-)-modafinil:malonic acid, R-(-)-modafinil:succinic acid, R-(-)-modafinil:citric acid, R-(-)-modafinil:DL-tartaric acid, R-(-)-modafinil:1-hydroxy-2-naphthoic acid, R-(-)-modafinil:lauric acid, R-(-)-modafinil:orotic acid, and R-(-)-modafinil:gentisic acid.

In another embodiment, the present invention provides a novel polymorph of racemic modafinil (form VII).

In another embodiment, the present invention provides the following modafinil solvates: acetic acid, tetrahydrofuran, 1,4-dioxane, methanol, nitromethane, acetone, o-xylene, benzene, and toluene.

Pharmaceutically acceptable co-crystals can be administered by controlled- or delayed-release means. Controlled-release pharmaceutical products have a common goal of improving drug therapy over that achieved by their non-controlled release counterparts. Ideally, the use of an optimally designed controlled-release preparation in medical treatment is characterized by a minimum of drug substance being employed to cure or control the condition in a minimum amount of time. Advantages of controlled-release formulations include: 1) extended activity of the drug; 2) reduced dosage

frequency; 3) increased patient compliance; 4) usage of less total drug; 5) reduction in local or systemic side effects; 6) minimization of drug accumulation; 7) reduction in blood level fluctuations; 8) improvement in efficacy of treatment; 9) reduction of potentiation or loss of drug activity; and 10) improvement in speed of control of diseases or conditions. (Kim, Cherng-ju, *Controlled Release Dosage Form Design*, 2 Technomic Publishing, Lancaster, Pa.: 2000).

Conventional dosage forms generally provide rapid or immediate drug release from the formulation. Depending on the pharmacology and pharmacokinetics of the drug, use of conventional dosage forms can lead to wide fluctuations in the concentrations of the drug in a patient's blood and other tissues. These fluctuations can impact a number of parameters, such as dose frequency, onset of action, duration of efficacy, maintenance of therapeutic blood levels, toxicity, side effects, and the like. Advantageously, controlled-release formulations can be used to control a drug's onset of action, duration of action, plasma levels within the therapeutic window, and peak blood levels. In particular, controlled- or extended-release dosage forms or formulations can be used to ensure that the maximum effectiveness of a drug is achieved while minimizing potential adverse effects and safety concerns, which can occur both from under dosing a drug (i.e., going below the minimum therapeutic levels) as well as exceeding the toxicity level for the drug.

Most controlled-release formulations are designed to initially release an amount of drug (active ingredient) that promptly produces the desired therapeutic effect, and gradually and continually release other amounts of drug to maintain this level of therapeutic or prophylactic effect over an extended period of time. In order to maintain this constant level of drug in the body, the drug must be released from the dosage form at a rate that will replace the amount of drug being metabolized and excreted from the body. Controlled-release of an active ingredient can be stimulated by various conditions including, but not limited to, pH, ionic strength, osmotic pressure, temperature, enzymes, water, and other physiological conditions or compounds.

A variety of known controlled- or extended-release dosage forms, formulations, and devices can be adapted for use with the co-crystals and compositions of the invention. Examples include, but are not limited to, those described in U.S. Pat. Nos.:



3,845,770; 3,916,899; 3,536,809; 3,598,123; 4,008,719; 5,674,533; 5,059,595; 5,591,767; 5,120,548; 5,073,543; 5,639,476; 5,354,556; 5,733,566; and 6,365,185 B1; each of which is incorporated herein by reference. These dosage forms can be used to provide slow or controlled-release of one or more active ingredients using, for example, hydroxypropylmethyl cellulose, other polymer matrices, gels, permeable membranes, osmotic systems (such as OROS® (Alza Corporation, Mountain View, Calif. USA)), multilayer coatings, microparticles, liposomes, or microspheres or a combination thereof to provide the desired release profile in varying proportions. Additionally, ion exchange materials can be used to prepare immobilized, adsorbed co-crystals and thus effect controlled delivery of the drug. Examples of specific anion exchangers include, but are not limited to, Duolite® A568 and Duolite® AP143 (Rohm & Haas, Spring House, PA. USA).

One embodiment of the invention encompasses a unit dosage form which comprises a pharmaceutically acceptable co-crystal, or a solvate, hydrate, dehydrate, anhydrous, or amorphous form thereof, and one or more pharmaceutically acceptable excipients or diluents, wherein the pharmaceutical composition, medicament or dosage form is formulated for controlled-release. Specific dosage forms utilize an osmotic drug delivery system.

A particular and well-known osmotic drug delivery system is referred to as OROS® (Alza Corporation, Mountain View, Calif. USA). This technology can readily be adapted for the delivery of compounds and compositions of the invention. Various aspects of the technology are disclosed in U.S. Pat. Nos. 6,375,978 B1; 6,368,626 B1; 6,342,249 B1; 6,333,050 B2; 6,287,295 B1; 6,283,953 B1; 6,270,787 B1; 6,245,357 B1; and 6,132,420; each of which is incorporated herein by reference. Specific adaptations of OROS® that can be used to administer compounds and compositions of the invention include, but are not limited to, the OROS® Push-Pull™, Delayed Push-Pull™, Multi-Layer Push-Pull™, and Push-Stick™ Systems, all of which are well known. See, e.g., <http://www.alza.com>. Additional OROS® systems that can be used for the controlled oral delivery of compounds and compositions of the invention include OROS®-CT and L-OROS®. Id.; see also, Delivery Times, vol. II, issue II (Alza Corporation).

Conventional OROS® oral dosage forms are made by compressing a drug powder (e.g. co-crystal) into a hard tablet, coating the tablet with cellulose derivatives to form a semi-permeable membrane, and then drilling an orifice in the coating (e.g., with a laser). Kim, Cherng-ju, Controlled Release Dosage Form Design, 231-238 (Technomic Publishing, Lancaster, Pa.: 2000). The advantage of such dosage forms is that the delivery rate of the drug is not influenced by physiological or experimental conditions. Even a drug with a pH-dependent solubility can be delivered at a constant rate regardless of the pH of the delivery medium. But because these advantages are provided by a build-up of osmotic pressure within the dosage form after administration, conventional OROS® drug delivery systems cannot be used to effectively deliver drugs with low water solubility. Id. at 234. Because co-crystals of this invention can be far more soluble in water than modafinil itself, they are well suited for osmotic-based delivery to patients. This invention does, however, encompass the incorporation of conventional crystalline modafinil (e.g. pure modafinil without co-crystal former), and isomers and isomeric mixtures thereof, into OROS® dosage forms.

A specific dosage form of the invention comprises: a wall defining a cavity, the wall having an exit orifice formed or formable therein and at least a portion of the wall being semipermeable; an expandable layer located within the cavity remote from the exit orifice and in fluid communication with the semipermeable portion of the wall; a dry or substantially dry state drug layer located within the cavity adjacent to the exit orifice and in direct or indirect contacting relationship with the expandable layer; and a flow-promoting layer interposed between the inner surface of the wall and at least the external surface of the drug layer located within the cavity, wherein the drug layer comprises a co-crystal, or a solvate, hydrate, dehydrate, anhydrous, or amorphous form thereof. See U.S. Pat. No. 6,368,626, the entirety of which is incorporated herein by reference.

Another specific dosage form of the invention comprises: a wall defining a cavity, the wall having an exit orifice formed or formable therein and at least a portion of the wall being semipermeable; an expandable layer located within the cavity remote from the exit orifice and in fluid communication with the semipermeable portion of the wall; a drug layer located within the cavity adjacent the exit orifice and in direct or indirect contacting relationship with the expandable layer; the drug layer comprising a liquid,

active agent formulation absorbed in porous particles, the porous particles being adapted to resist compaction forces sufficient to form a compacted drug layer without significant exudation of the liquid, active agent formulation, the dosage form optionally having a placebo layer between the exit orifice and the drug layer, wherein the active agent formulation comprises a co-crystal, or a solvate, hydrate, dehydrate, anhydrous, or amorphous form thereof. See U.S. Pat. No. 6,342,249, the entirety of which is incorporated herein by reference.

In another embodiment, a pharmaceutical composition or medicament comprises a mixture of a novel form of modafinil of the present invention (e.g., a co-crystal) and the free form of modafinil. This embodiment can be used, for example, as a controlled-, sustained-, or extended-release dosage form. In another embodiment, an extended-release dosage form comprises free form modafinil and a co-crystal or a solvate of the present invention. Such an extended-release dosage form contains modafinil in a form (e.g. modafinil:malonic acid co-crystal) which has a greater bioavailability than that of free form modafinil. In addition, the  $C_{max}$  of such a form can be greater than that of free form modafinil, facilitating a therapeutic effect with longer duration than free form modafinil alone.

In another embodiment, a pharmaceutical composition or medicament comprises a modified release profile of one or more of racemic modafinil, R-(-)-modafinil, and S-(+)-modafinil. The modified release profile can comprise, for example, two or more maxima of plasma concentration, such as a dual-release profile. Such a modified release profile may aid a patient treated with a composition or medicament of the present invention who experiences loss of wakefulness in the afternoon, for example. A second "burst" or release of API at least 2, 3, 4, 5, or 6 hours after administration may help to overcome such an effect. In another embodiment, a pharmaceutical composition or medicament comprising a small loading dose released immediately following administration can be employed, followed by an approximate zero-order release profile over the following 2, 3, 4, 5, or 6 hours. In such a composition, peak plasma levels can be reached at about midday.

In another embodiment, a pharmaceutical composition or medicament comprising a modified release profile of modafinil can comprise R-(-)-modafinil and S-(+)-modafinil

wherein the R-(-)-modafinil provides an initial increase (initial  $C_{max}$  due to R-(-)-modafinil) in plasma concentration and the S-(+)-modafinil provides a delayed increase (subsequent  $C_{max}$  due to S-(+)-modafinil) in plasma concentration. The delayed increase in  $C_{max}$  due to S-(+)-modafinil can be 2, 3, 4, 5, 6 hours or more after the initial  $C_{max}$  due to R-(-)-modafinil. In another embodiment, the delayed  $C_{max}$  is approximately equal to the initial  $C_{max}$ . In another embodiment, the delayed  $C_{max}$  is greater than the initial  $C_{max}$ . In another embodiment, the delayed  $C_{max}$  is less than the initial  $C_{max}$ . In another embodiment, the delayed  $C_{max}$  is due to racemic modafinil, instead of S-(+)-modafinil. In another embodiment, the delayed  $C_{max}$  is due to R-(-)-modafinil, instead of S-(+)-modafinil. In another embodiment, the initial  $C_{max}$  is due to racemic modafinil, instead of R-(-)-modafinil. In another embodiment, the initial  $C_{max}$  is due to S-(+)-modafinil, instead of R-(-)-modafinil. In another embodiment, the modified release profile has 3, 4, 5, or more "bursts" in plasma concentration.

In another embodiment, a pharmaceutical composition or medicament comprising a modified release profile of modafinil wherein one or more of racemic modafinil, R-(-)-modafinil, or S-(+)-modafinil are present in the form of a co-crystal, solvate, free form, or a polymorph thereof.

In another embodiment, a pharmaceutical composition or medicament comprising a modified release profile wherein R-(-)-modafinil is used in an oral formulation. Such a composition can minimize first-pass metabolism of modafinil to the sulfone. In another embodiment, a pharmaceutical composition or medicament comprising a modified release profile wherein racemic modafinil is used in an oral formulation. In another embodiment, a pharmaceutical composition or medicament comprising a modified release profile wherein S-(+)-modafinil is used in an oral formulation. In another embodiment, a pharmaceutical composition or medicament comprising a modified release profile wherein racemic modafinil and R-(-)-modafinil are used in an oral formulation. In another embodiment, a pharmaceutical composition or medicament comprising a modified release profile wherein racemic modafinil and S-(+)-modafinil are used in an oral formulation. In another embodiment, a pharmaceutical composition or medicament comprising a modified release profile wherein S-(+)-modafinil and R-(-)-modafinil are used in an oral formulation. In another embodiment, a pharmaceutical

composition or medicament comprising a modified release profile wherein racemic modafinil, S-(+)-modafinil and R-(-)-modafinil are used in an oral formulation.

In another embodiment, a pharmaceutical composition or medicament comprising a modified release profile of modafinil is administered transdermally. Such a transdermal (TD) delivery can avoid first-pass metabolism. Additionally, a "pill-and-patch" strategy can be taken, where only a fraction of the daily dose is delivered through the skin to generate basal systemic levels, onto which oral therapy is added to ensure the wakefulness effect.

Excipients employed in pharmaceutical compositions and medicaments of the present invention can be solids, semi-solids, liquids or combinations thereof. Preferably, excipients are solids. Compositions and medicaments of the invention containing excipients can be prepared by known technique of pharmacy that comprises admixing an excipient with an API or therapeutic agent. A pharmaceutical composition or medicament of the invention contains a desired amount of API per dose unit and, if intended for oral administration, can be in the form, for example, of a tablet, a caplet, a pill, a hard or soft capsule, a lozenge, a cachet, a dispensable powder, granules, a suspension, an elixir, a dispersion, a liquid, or any other form reasonably adapted for such administration. If intended for parenteral administration, it can be in the form, for example, of a suspension or transdermal patch. If intended for rectal administration, it can be in the form, for example, of a suppository. Presently preferred are oral dosage forms that are discrete dose units each containing a predetermined amount of the API, such as tablets or capsules.

Non-limiting examples follow of excipients that can be used to prepare pharmaceutical compositions or medicaments of the invention.

Pharmaceutical compositions and medicaments of the invention optionally comprise one or more pharmaceutically acceptable carriers or diluents as excipients. Suitable carriers or diluents illustratively include, but are not limited to, either individually or in combination, lactose, including anhydrous lactose and lactose monohydrate; starches, including directly compressible starch and hydrolyzed starches (e.g., Celutab<sup>TM</sup> and Emdex<sup>TM</sup>); mannitol; sorbitol; xylitol; dextrose (e.g., Cerelease<sup>TM</sup> 2000) and dextrose monohydrate; dibasic calcium phosphate dihydrate; sucrose-based

diluents; confectioner's sugar; monobasic calcium sulfate monohydrate; calcium sulfate dihydrate; granular calcium lactate trihydrate; dextrates; inositol; hydrolyzed cereal solids; amylose; celluloses including microcrystalline cellulose, food grade sources of alpha- and amorphous cellulose (e.g., RexcelJ), powdered cellulose, hydroxypropylcellulose (HPC) and hydroxypropylmethylcellulose (HPMC); calcium carbonate; glycine; bentonite; block co-polymers; polyvinylpyrrolidone; and the like. Such carriers or diluents, if present, constitute in total about 5% to about 99%, preferably about 10% to about 85%, and more preferably about 20% to about 80%, of the total weight of the composition. The carrier, carriers, diluent, or diluents selected preferably exhibit suitable flow properties and, where tablets are desired, compressibility.

Lactose, mannitol, dibasic sodium phosphate, and microcrystalline cellulose (particularly Avicel PH microcrystalline cellulose such as Avicel PH 101), either individually or in combination, are preferred diluents. These diluents are chemically compatible with APIs. The use of extragranular microcrystalline cellulose (that is, microcrystalline cellulose added to a granulated composition) can be used to improve hardness (for tablets) and/or disintegration time. Lactose, especially lactose monohydrate, is particularly preferred. Lactose typically provides compositions having suitable release rates of APIs, stability, pre-compression flowability, and/or drying properties at a relatively low diluent cost. It provides a high density substrate that aids densification during granulation (where wet granulation is employed) and therefore improves blend flow properties and tablet properties.

Pharmaceutical compositions and medicaments of the invention optionally comprise one or more pharmaceutically acceptable disintegrants as excipients, particularly for tablet formulations. Suitable disintegrants include, but are not limited to, either individually or in combination, starches, including sodium starch glycolate (e.g., Explotab<sup>TM</sup> of PenWest) and pregelatinized corn starches (e.g., National<sup>TM</sup> 1551 of National Starch and Chemical Company, National<sup>TM</sup> 1550, and Colocorn<sup>TM</sup> 1500), clays (e.g., Veegum<sup>TM</sup> HV of R.T. Vanderbilt), celluloses such as purified cellulose, microcrystalline cellulose, methylcellulose, carboxymethylcellulose and sodium carboxymethylcellulose, croscarmellose sodium (e.g., Ac-Di-Sol<sup>TM</sup> of FMC), alginates,

crospovidone, and gums such as agar, guar, locust bean, karaya, pectin and tragacanth gums.

Disintegrants may be added at any suitable step during the preparation of the composition, particularly prior to granulation or during a lubrication step prior to compression. Such disintegrants, if present, constitute in total about 0.2% to about 30%, preferably about 0.2% to about 10%, and more preferably about 0.2% to about 5%, of the total weight of the composition.

Croscarmellose sodium is a preferred disintegrant for tablet or capsule disintegration, and, if present, preferably constitutes about 0.2% to about 10%, more preferably about 0.2% to about 7%, and still more preferably about 0.2% to about 5%, of the total weight of the composition. Croscarmellose sodium confers superior intragranular disintegration capabilities to granulated pharmaceutical compositions and medicaments of the present invention.

Pharmaceutical compositions and medicaments of the invention optionally comprise one or more pharmaceutically acceptable binding agents or adhesives as excipients, particularly for tablet formulations. Such binding agents and adhesives preferably impart sufficient cohesion to the powder being tableted to allow for normal processing operations such as sizing, lubrication, compression and packaging, but still allow the tablet to disintegrate and the composition to be absorbed upon ingestion. Such binding agents may also prevent or inhibit crystallization or recrystallization of an API of the present invention once the salt has been dissolved in a solution. Suitable binding agents and adhesives include, but are not limited to, either individually or in combination, acacia; tragacanth; sucrose; gelatin; glucose; starches such as, but not limited to, pregelatinized starches (e.g., National<sup>TM</sup> 1511 and National<sup>TM</sup> 1500); celluloses such as, but not limited to, methylcellulose and carmellose sodium (e.g., Tylose<sup>TM</sup>); alginic acid and salts of alginic acid; magnesium aluminum silicate; PEG; guar gum; polysaccharide acids; bentonites; povidone, for example povidone K-15, K-30 and K-29/32; polymethacrylates; HPMC; hydroxypropylcellulose (e.g., Klucel<sup>TM</sup> of Aqualon); and ethylcellulose (e.g., Ethocel<sup>TM</sup> of the Dow Chemical Company). Such binding agents and/or adhesives, if present, constitute in total about 0.5% to about 25%, preferably about

0.75% to about 15%, and more preferably about 1% to about 10%, of the total weight of the pharmaceutical composition or medicament.

Many of the binding agents are polymers comprising amide, ester, ether, alcohol or ketone groups and, as such, are preferably included in pharmaceutical compositions and medicaments of the present invention. Polyvinylpyrrolidones such as povidone K-30 are especially preferred. Polymeric binding agents can have varying molecular weight, degrees of crosslinking, and grades of polymer. Polymeric binding agents can also be copolymers, such as block co-polymers that contain mixtures of ethylene oxide and propylene oxide units. Variation in these units' ratios in a given polymer affects properties and performance. Examples of block co-polymers with varying compositions of block units are Poloxamer 188 and Poloxamer 237 (BASF Corporation).

Pharmaceutical compositions and medicaments of the invention optionally comprise one or more pharmaceutically acceptable wetting agents as excipients. Such wetting agents are preferably selected to maintain the API in close association with water, a condition that is believed to improve bioavailability of the composition.

Non-limiting examples of surfactants that can be used as wetting agents in pharmaceutical compositions and medicaments of the invention include quaternary ammonium compounds, for example benzalkonium chloride, benzethonium chloride and cetylpyridinium chloride, dioctyl sodium sulfosuccinate, polyoxyethylene alkylphenyl ethers, for example nonoxynol 9, nonoxynol 10, and octoxynol 9, poloxamers (polyoxyethylene and polyoxypropylene block copolymers), polyoxyethylene fatty acid glycerides and oils, for example polyoxyethylene (8) caprylic/capric mono- and diglycerides (e.g., Labrasol<sup>TM</sup> of Gattefosse), polyoxyethylene (35) castor oil and polyoxyethylene (40) hydrogenated castor oil; polyoxyethylene alkyl ethers, for example polyoxyethylene (20) cetostearyl ether, polyoxyethylene fatty acid esters, for example polyoxyethylene (40) stearate, polyoxyethylene sorbitan esters, for example polysorbate 20 and polysorbate 80 (e.g., Tween<sup>TM</sup> 80 of ICI), propylene glycol fatty acid esters, for example propylene glycol laurate (e.g., Lauroglycol<sup>TM</sup> of Gattefosse), sodium lauryl sulfate, fatty acids and salts thereof, for example oleic acid, sodium oleate and triethanolamine oleate, glyceryl fatty acid esters, for example glyceryl monostearate, sorbitan esters, for example sorbitan monolaurate, sorbitan monooleate, sorbitan



monopalmitate and sorbitan monostearate, tyloxapol, and mixtures thereof. Such wetting agents, if present, constitute in total about 0.25% to about 15%, preferably about 0.4% to about 10%, and more preferably about 0.5% to about 5%, of the total weight of the pharmaceutical composition or medicament.

Wetting agents that are anionic surfactants are preferred. Sodium lauryl sulfate is a particularly preferred wetting agent. Sodium lauryl sulfate, if present, constitutes about 0.25% to about 7%, more preferably about 0.4% to about 4%, and still more preferably about 0.5% to about 2%, of the total weight of the pharmaceutical composition or medicament.

Pharmaceutical compositions and medicaments of the invention optionally comprise one or more pharmaceutically acceptable lubricants (including anti-adherents and/or glidants) as excipients. Suitable lubricants include, but are not limited to, either individually or in combination, glyceryl behapate (e.g., Compritol<sup>TM</sup> 888 of Gattefosse); stearic acid and salts thereof, including magnesium, calcium and sodium stearates; hydrogenated vegetable oils (e.g., Sterotex<sup>TM</sup> of Abitec); colloidal silica; talc; waxes; boric acid; sodium benzoate; sodium acetate; sodium fumarate; sodium chloride; DL-leucine; PEG (e.g., Carbowax<sup>TM</sup> 4000 and Carbowax<sup>TM</sup> 6000 of the Dow Chemical Company); sodium oleate; sodium lauryl sulfate; and magnesium lauryl sulfate. Such lubricants, if present, constitute in total about 0.1% to about 10%, preferably about 0.2% to about 8%, and more preferably about 0.25% to about 5%, of the total weight of the pharmaceutical composition or medicament.

Magnesium stearate is a preferred lubricant used, for example, to reduce friction between the equipment and granulated mixture during compression of tablet formulations.

Suitable anti-adherents include, but are not limited to, talc, cornstarch, DL-leucine, sodium lauryl sulfate and metallic stearates. Talc is a preferred anti-adherent or glidant used, for example, to reduce formulation sticking to equipment surfaces and also to reduce static in the blend. Talc, if present, constitutes about 0.1% to about 10%, more preferably about 0.25% to about 5%, and still more preferably about 0.5% to about 2%, of the total weight of the pharmaceutical composition or medicament.

Glidants can be used to promote powder flow of a solid formulation. Suitable glidants include, but are not limited to, colloidal silicon dioxide, starch, talc, tribasic calcium phosphate, powdered cellulose and magnesium trisilicate. Colloidal silicon dioxide is particularly preferred.

Other excipients such as colorants, flavors and sweeteners are known in the pharmaceutical art and can be used in pharmaceutical compositions and medicaments of the present invention. Tablets can be coated, for example with an enteric coating, or uncoated. Compositions of the invention can further comprise, for example, buffering agents.

Optionally, one or more effervescent agents can be used as disintegrants and/or to enhance organoleptic properties of pharmaceutical compositions and medicaments of the invention. When present in pharmaceutical compositions and medicaments of the invention to promote dosage form disintegration, one or more effervescent agents are preferably present in a total amount of about 30% to about 75%, and preferably about 45% to about 70%, for example about 60%, by weight of the pharmaceutical composition or medicament.

According to a particularly preferred embodiment of the invention, an effervescent agent, present in a solid dosage form in an amount less than that effective to promote disintegration of the dosage form, provides improved dispersion of the API in an aqueous medium. Without being bound by theory, it is believed that the effervescent agent is effective to accelerate dispersion of the API, from the dosage form in the gastrointestinal tract, thereby further enhancing absorption and rapid onset of therapeutic effect. When present in a pharmaceutical composition or medicament of the invention to promote intragastric dispersion but not to enhance disintegration, an effervescent agent is preferably present in an amount of about 1% to about 20%, more preferably about 2.5% to about 15%, and still more preferably about 5% to about 10%, by weight of the pharmaceutical composition or medicament.

An "effervescent agent" herein is an agent comprising one or more compounds which, acting together or individually, evolve a gas on contact with water. The gas evolved is generally oxygen or, most commonly, carbon dioxide. Preferred effervescent agents comprise an acid and a base that react in the presence of water to generate carbon

dioxide gas. Preferably, the base comprises an alkali metal or alkaline earth metal carbonate or bicarbonate and the acid comprises an aliphatic carboxylic acid.

Non-limiting examples of suitable bases as components of effervescent agents useful in the invention include carbonate salts (e.g., calcium carbonate), bicarbonate salts (e.g., sodium bicarbonate), sesquicarbonate salts, and mixtures thereof. Calcium carbonate is a preferred base.

Non-limiting examples of suitable acids as components of effervescent agents and/or solid acids useful in the invention include citric acid, tartaric acid (as D-, L-, or D/L-tartaric acid), malic acid, maleic acid, fumaric acid, adipic acid, succinic acid, acid anhydrides of such acids, acid salts of such acids, and mixtures thereof. Citric acid is a preferred acid.

In a preferred embodiment of the invention, where the effervescent agent comprises an acid and a base, the weight ratio of the acid to the base is about 1:100 to about 100:1, more preferably about 1:50 to about 50:1, and still more preferably about 1:10 to about 10:1. In a further preferred embodiment of the invention, where the effervescent agent comprises an acid and a base, the ratio of the acid to the base is approximately stoichiometric.

Excipients which solubilize metal salts of APIs typically have both hydrophilic and hydrophobic regions, or are preferably amphiphilic or have amphiphilic regions. One type of amphiphilic or partially-amphiphilic excipient comprises an amphiphilic polymer or is an amphiphilic polymer. A specific amphiphilic polymer is a polyalkylene glycol, which is commonly comprised of ethylene glycol and/or propylene glycol subunits. Such polyalkylene glycols can be esterified at their termini by a carboxylic acid, ester, acid anhydride or other suitable moiety. Examples of such excipients include poloxamers (symmetric block copolymers of ethylene glycol and propylene glycol; e.g., poloxamer 237), polyalkylene glycolated esters of tocopherol (including esters formed from a di- or multi-functional carboxylic acid; e.g., d-alpha-tocopherol polyethylene glycol-1000 succinate), and macroglycerides (formed by alcoholysis of an oil and esterification of a polyalkylene glycol to produce a mixture of mono-, di- and tri-glycerides and mono- and di-esters; e.g., stearyl macrogol-32 glycerides). Such pharmaceutical compositions and medicaments are advantageously administered orally.

Pharmaceutical compositions and medicaments of the present invention can comprise about 10% to about 50%, about 25% to about 50%, about 30% to about 45%, or about 30% to about 35% by weight of API; about 10% to about 50%, about 25% to about 50%, about 30% to about 45%, or about 30% to about 35% by weight of an excipient which inhibits crystallization; and about 5% to about 50%, about 10% to about 40%, about 15% to about 35%, or about 30% to about 35% by weight of a binding agent. In one example, the weight ratio of the API to the excipient which inhibits crystallization to binding agent is about 1 to 1 to 1.

Solid dosage forms of the invention can be prepared by any suitable process, not limited to processes described herein.

An illustrative process comprises (a) a step of blending a salt of the invention with one or more excipients to form a blend, and (b) a step of tableting or encapsulating the blend to form tablets or capsules, respectively.

In a preferred process, solid dosage forms are prepared by a process comprising (a) a step of blending an API salt of the invention with one or more excipients to form a blend, (b) a step of granulating the blend to form a granulate, and (c) a step of tableting or encapsulating the blend to form tablets or capsules respectively. Step (b) can be accomplished by any dry or wet granulation technique known in the art, but is preferably a dry granulation step. A salt of the present invention is advantageously granulated to form particles of about 1 micrometer to about 100 micrometer, about 5 micrometer to about 50 micrometer, or about 10 micrometer to about 25 micrometer. One or more diluents, one or more disintegrants and one or more binding agents are preferably added, for example in the blending step, a wetting agent can optionally be added, for example in the granulating step, and one or more disintegrants are preferably added after granulating but before tableting or encapsulating. A lubricant is preferably added before tableting. Blending and granulating can be performed independently under low or high shear. A process is preferably selected that forms a granulate that is uniform in API content, that readily disintegrates, that flows with sufficient ease so that weight variation can be reliably controlled during capsule filling or tableting, and that is dense enough in bulk so that a batch can be processed in the selected equipment and individual doses fit into the specified capsules or tablet dies.

In an alternative embodiment, solid dosage forms are prepared by a process that includes a spray drying step, wherein the API is suspended with one or more excipients in one or more sprayable liquids, preferably a non-protic (e.g., non-aqueous or non-alcoholic) sprayable liquid, and then is rapidly spray dried over a current of warm air.

A granulate or spray dried powder resulting from any of the above illustrative processes can be compressed or molded to prepare tablets or encapsulated to prepare capsules. Conventional tableting and encapsulation techniques known in the art can be employed. Where coated tablets are desired, conventional coating techniques are suitable.

Excipients for tablet compositions of the invention are preferably selected to provide a disintegration time of less than about 30 minutes, preferably about 25 minutes or less, more preferably about 20 minutes or less, and still more preferably about 15 minutes or less, in a standard disintegration assay.

In another embodiment of the present invention, a pharmaceutical composition or medicament comprising modafinil and an additional API can be prepared. The modafinil and the additional API can be in the form of a co-crystal, or may be included as a mixture or a combination of active pharmaceutical ingredients. For example, a composition can comprise modafinil and caffeine as a combination. A composition comprising modafinil and caffeine can be used as a therapeutic agent to treat the same conditions as modafinil. In such a composition comprising modafinil and caffeine, the caffeine can yield a quick release characteristic (small  $T_{max}$  relative to modafinil) to the dissolution profile while the modafinil causes the therapeutic effect to be present for hours after administration. For example, the  $T_{max}$  of caffeine may be 0.001, 0.01, 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, or 0.8 times that of modafinil. Combination therapies comprise the administration of two or more APIs in the same formulation, or in two or more co-administered formulations. The APIs can be administered together at the same time, or individually at specified intervals.

In a further embodiment, the present invention provides a novel polymorph of R-(-)-modafinil. In a specific embodiment, the present invention provides Forms I, II, III, IV, and V of R-(-)-modafinil. The present invention also provides a method of making a polymorph of R-(-)-modafinil.

In a further embodiment, the present invention provides a method of making a polymorph of R-(-)-modafinil, comprising:

- (a) providing R-(-)-modafinil; and
- (b) crystallizing the polymorph of R-(-)-modafinil from an appropriate solvent.

In a further embodiment, a polymorph of R-(-)-modafinil is crystallized from an organic solvent. In a particular embodiment, the organic solvent is ethanol. In another embodiment, a mixed solvent system is used to crystallize a polymorph of R-(-)-modafinil. Mixed solvent systems can be, for example, ethanol and isopropyl alcohol, or ethyl acetate and ethanol. In a further embodiment, the crystallization in step (b) is completed via thermal recrystallization. In a further embodiment, the crystallization in step (b) is completed via evaporation of the solvent.

Uses for modafinil are well known in the art and include the treatment of narcolepsy, multiple sclerosis related fatigue, infertility, eating disorders, attention deficit hyperactivity disorder (ADHD), Parkinson's disease, incontinence, sleep apnea, or myopathies. The dosage and administration for modafinil compositions of the present invention can be determined using routine methods in the art but will generally fall between about 50 and about 700 mg/day.

## EXAMPLES

### General Methods for the Preparation of Co-Crystals

a) High Throughput crystallization using the CrystalMax<sup>TM</sup> platform  
CrystalMax<sup>TM</sup> comprises a sequence of automated, integrated high throughput robotic stations capable of rapid generation, identification and characterization of polymorphs, salts, and co-crystals of APIs and API candidates. Worksheet generation and combinatorial mixture design is carried out using proprietary design software Architect<sup>TM</sup>. Typically, an API or an API candidate is dispensed from an organic solvent into tubes and dried under a stream of nitrogen. Salts and/or co-crystal formers may also be dispensed and dried in the same fashion. Water and organic solvents may be combinatorially dispensed into the tubes using a multi-channel dispenser. Each tube in a

96-tube array is then sealed within 15 seconds of combinatorial dispensing to avoid solvent evaporation. The mixtures are then rendered supersaturated by heating to 70 degrees C for 2 hours followed by a 1 degree C/minute cooling ramp to 5 degrees C. Optical checks are then conducted to detect crystals and/or solid material. Once a solid has been identified in a tube, it is isolated through aspiration and drying. Raman spectra are then obtained on the solids and cluster classification of the spectral patterns is performed using proprietary software (Inquire™).

**b) Crystallization from solution**

Co-crystals may be obtained by dissolving the separate components in a solvent and adding one to the other. The co-crystal may then precipitate or crystallize as the solvent mixture is evaporated slowly. The co-crystal may also be obtained by dissolving the two components in the same solvent or a mixture of solvents. The co-crystal may also be obtained by seeding a saturated solution of the two components and seeding with a ground mixture of the co-crystal.

**c) Crystallization from the melt (Co-melting)**

A co-crystal may be obtained by melting the two components together (i.e., co-melting) and allowing recrystallization to occur. In some cases, an anti-solvent may be added to facilitate crystallization.

**d) Thermal microscopy**

A co-crystal may be obtained by melting the higher melting component on a glass slide and allowing it to recrystallize. The second component is then melted and is also allowed to recrystallize. The co-crystal may form as a separated phase/band in between the eutectic bands of the two original components.

**e) Mixing and/or grinding**

A co-crystal may be obtained by mixing or grinding two components together in the solid state. For example, Example 12 describes the synthesis of a modafinil:1-hydroxy-2-naphthoic acid co-crystal obtained by milling with the addition of a small amount of an

appropriate solvent. Similarly, Example 5 describes the synthesis of a modafinil: citric acid monohydrate co-crystal obtained by milling both with and without the addition of a small amount of an appropriate solvent. In one embodiment, a co-crystal is prepared via milling or grinding modafinil with a co-crystal former. In another embodiment, a co-crystal is prepared via milling or grinding modafinil, a co-crystal former, and a small amount of solvent.

In another embodiment, a co-crystal is prepared with the addition of solvent, without the addition of solvent, or both. Solvents used in such a co-crystallization process can be, for example, but not limited to, acetone, methanol, ethanol, isopropyl alcohol, ethyl acetate, isopropyl acetate, nitromethane, dichloromethane, chloroform, toluene, propylene glycol, dimethyl sulfoxide (DMSO), dimethyl formamide (DMF), diethyl ether (ether), ethyl formate, hexane, acetonitrile, or another organic solvent including alcohols.

#### f) Co-sublimation

A co-crystal may be obtained by co-subliming a mixture of an API and a co-crystal former in the same sample cell as an intimate mixture either by heating, mixing or placing the mixture under vacuum. A co-crystal may also be obtained by co-sublimation using a Kneudsen apparatus where the API and the co-crystal former are contained in separate sample cells, connected to a single cold finger, each of the sample cells is maintained at the same or different temperatures under a vacuum atmosphere in order to co-sublime the two components onto the cold-finger forming the desired co-crystal.

#### Analytical Methods

Differential scanning calorimetric (DSC) analysis of the samples was performed using a Q1000 Differential Scanning Calorimeter (TA Instruments, New Castle, DE, U.S.A.), which uses Advantage for QW-Series, version 1.0.0.78, Thermal Advantage Release 2.0 (2001 TA Instruments-Water LLC). In addition, the analysis software used was Universal Analysis 2000 for Windows 95/98/2000/NT, version 3.1E; Build 3.1.0.40 (2001 TA Instruments-Water LLC).



For the DSC analysis, the purge gas used was dry nitrogen, the reference material was an empty aluminum pan that was crimped, and the sample purge was 50 mL/minute.

DSC analysis of the sample was performed by placing the modafinil sample in an aluminum pan with a crimped pan closure. The starting temperature was typically 20 degrees C with a heating rate of 10 degrees C/minute, and the ending temperature was 200 degrees C. All reported DSC transitions represent the temperature of endothermic or exothermic transition at their respective peaks with an error of +/- 2 degrees C, unless otherwise indicated.

Thermogravimetric analysis (TGA) of samples was performed using a Q500 Thermogravimetric Analyzer (TA Instruments, New Castle, DE, U.S.A.), which uses Advantage for QW-Series, version 1.0.0.78, Thermal Advantage Release 2.0 (2001 TA Instruments-Water LLC). In addition, the analysis software used was Universal Analysis 2000 for Windows 95/98/2000/NT, version 3.1E; Build 3.1.0.40 (2001 TA Instruments-Water LLC).

For the TGA experiments, the purge gas used was dry nitrogen, the balance purge was 40 mL/minute N<sub>2</sub>, and the sample purge was 60 mL/minute N<sub>2</sub>.

TGA was performed on the sample by placing the modafinil sample in a platinum pan. The starting temperature was typically 20 degrees C with a heating rate of 10 degrees C/minute, and the ending temperature was 300 degrees C.

A powder X-ray diffraction (PXRD) pattern for the samples was obtained using a D/Max Rapid, Contact (Rigaku/MS, The Woodlands, TX, U.S.A.), which uses as its control software RINT Rapid Control Software, Rigaku Rapid/XRD, version 1.0.0 (1999 Rigaku Co.). In addition, the analysis software used were RINT Rapid display software, version 1.18 (Rigaku/MS), and JADE XRD Pattern Processing, versions 5.0 and 6.0 ((1995-2002, Materials Data, Inc.).

For the PXRD analysis, the acquisition parameters were as follows: source was Cu with a K line at 1.5406 Å; x-y stage was manual; collimator size was 0.3 mm; capillary tube (Charles Supper Company, Natick, MA, U.S.A.) was 0.3 mm ID; reflection mode was used; the power to the X-ray tube was 46 kV; the current to the X-ray tube was 40 mA; the omega-axis was oscillating in a range of 0-5 degrees at a speed of 1 degree/minute; the phi-axis was spinning at an angle of 360 degrees at a speed of 2

degrees/second; 0.3 mm collimator; the collection time was 60 minutes; the temperature was room temperature; and the heater was not used. The sample was presented to the X-ray source in a boron rich glass capillary.

In addition, the analysis parameters were as follows: the integration 2-theta range was 2-60 degrees; the integration chi range was 0-360 degrees; the number of chi segments was 1; the step size used was 0.02; the integration utility was cylint; normalization was used; dark counts were 8; omega offset was 180; and chi and phi offsets were 0.

PXRD diffractograms were also acquired via the Bruker AXS D8 Discover X-ray Diffractometer. This instrument was equipped with GADDS<sup>TM</sup> (General Area Diffraction Detection System), a Bruker AXS HI-STAR Area Detector at a distance of 15.05 cm as per system calibration, a copper source (Cu/K $\alpha$  1.54056 angstroms), automated x-y-z stage, and 0.5mm collimator. The sample was compacted into pellet form and mounted on the x-y-z stage. A diffractogram was acquired under ambient conditions at a powder setting of 40kV and 40mA in reflection mode while the sample remained stationary. The exposure time was varied and specified for each sample. The diffractogram obtained underwent a spatial remapping procedure to account for the geometrical pincushion distortion of the area detector then integrated along chi from -118.8 to -61.8 degrees and 2-theta 2.1-37 degrees at a step size of 0.02 degrees with normalization set to bin normalize.

The relative intensity of peaks in a diffractogram is not necessarily a limitation of the PXRD pattern because peak intensity can vary from sample to sample, e.g., due to crystalline impurities. Further, the angles of each peak can vary by about  $\pm 0.1$  degrees, preferably  $\pm 0.05$ . The entire pattern or most of the pattern peaks may also shift by about  $\pm 0.1$  degree due to differences in calibration, settings, and other variations from instrument to instrument and from operator to operator. All reported PXRD peaks in the Figures, Examples, and elsewhere herein are reported with an error of about  $\pm 0.1$  degrees 2-theta.

For PXRD data herein, including Tables and Figures, each composition of the present invention may be characterized by any one, any two, any three, any four, any five, any six, any seven, or any eight or more of the 2 theta angle peaks. Any one, two,

three, four, five, or six DSC transitions can also be used to characterize the compositions of the present invention. The different combinations of the PXRD peaks and the DSC transitions can also be used to characterize the compositions.

Thermal (hotstage) microscopy was completed on a Zeiss Axioplan 2 microscope equipped with a Mettler Toledo FP90 controller. The hotstage used was a Mettler Toledo FP82HT. All melting point determinations were completed by placing the sample on a microscope slide and covered with a coverslip. The initial temperature was set at 30 degrees C and the temperature was increased at a rate of 10 degrees C/minute. Melting was observed through a 5x microscope objective.

Data for the co-crystals are shown in Table IV and in the Figures.

#### Example 1

##### Racemic Modafinil:Malonic acid Co-crystal

Using a 250 mg/mL racemic modafinil-acetic acid solution, malonic acid was dissolved on a hotplate (about 67 degrees C) at a 1:2 modafinil to malonic acid ratio. The mixture was dried under flowing nitrogen overnight. A powdery white solid was produced. After further drying for 1 day, acetic acid was removed (as determined by TGA) and the crystal structure, as determined by PXRD, remained the same. PXRD data for the modafinil:malonic acid (1:1) co-crystal are listed in Table IV, and the diffractogram is shown in Figure 1 (Data as collected). DSC showed an endothermic transition at 106.23 degrees C, and the thermogram is shown in Figure 2. TGA thermogram is shown in Figure 3. Figures 4A and 4B show a Raman spectrum of the modafinil:malonic acid co-crystal and three Raman spectra of modafinil, malonic acid, and the co-crystal, respectively. Figures 5A and 5B show an IR spectrum of the modafinil:malonic acid co-crystal and three IR spectra of modafinil, malonic acid, and the co-crystal, respectively. The modafinil:malonic acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 1 including, but not limited to, 5.00, 9.17, 10.08, 16.81, 18.26, 19.43, 21.36, 21.94, 22.77, 24.49, 25.63, 26.37, and 28.45 degrees 2-theta.

The modafinil:malonic acid co-crystal was also prepared by grinding the API and co-crystal former together. 2.50 g of modafinil was mixed with 1.01 g of malonic acid in

a large mortar and pestle (malonic acid added in increments over 7 days with about a 1:1.05 ratio made on the first day and increments added over the next seven days which resulted in a 1:2 modafinil:malonic acid ratio). The mixture was ground for 45 minutes initially and 20 minutes each time more malonic acid was added. On the seventh day the mixture of co-crystal and starting components was heated in a sealed 20 mL vial at 80 degrees C for about 35 minutes to facilitate completion of the co-crystal formation. PXRD analysis of the resultant material was completed, and is shown in Figure 6 (background subtracted). The modafinil:malonic acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 6 including, but not limited to, 5.11, 9.35, 16.87, 18.33, 19.53, 21.38, 22.05, 22.89, 23.57, 24.73, 25.19, and 28.59 degrees 2-theta. Single crystal data of the modafinil:malonic acid co-crystal were acquired and are reported below. Figure 7 shows a packing diagram of the modafinil:malonic acid.

Crystal data:  $C_{18}H_{19}NO_6S$ ,  $M = 377.40$ , monoclinic  $C2/c$ ;  $a = 18.728(8)$  angstroms,  $b = 5.480(2)$  angstroms,  $c = 33.894(13)$  angstroms,  $\alpha = 90$  degrees,  $\beta = 91.864(9)$  degrees,  $\gamma = 90$  degrees,  $T = 100(2)$  K,  $Z = 8$ ,  $D_c = 1.442$  Mg/m<sup>3</sup>,  $U = 3477(2)$  cubic angstroms,  $\lambda = 0.71073$  angstroms, 6475 reflections measured, 3307 unique ( $R_{int} = 0.1567$ ). Final residuals were  $R_1 = 0.1598$ ,  $wR_2 = 0.3301$  for  $I > 2\sigma(I)$ , and  $R_1 = 0.2544$ ,  $wR_2 = 0.3740$  for all 3307 data.

Other methods were also used to prepare the modafinil:malonic acid co-crystal. A third preparation was performed by placing equimolar amounts of modafinil (30 mg, 0.0001 mol) and malonic acid in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized using PXRD and DSC. In yet another preparation of the modafinil:malonic acid co-crystal, the third preparation above was completed without the addition of solvent. All of the above methods with malonic acid were shown to yield the same co-crystal via PXRD and DSC analysis.

## Example 2

### Racemic Modafinil:Glycolic acid Co-crystal

Racemic modafinil (1 mg, 0.0037mmol) and glycolic acid (0.30 mg, 0.0037 mmol) were dissolved in acetone (400 microliters). The solution was allowed to evaporate to dryness and the resulting solid was characterized using PXRD. PXRD data for the modafinil:glycolic acid co-crystal are listed in Table IV. See Figures 8A and 8B. Figure 8A shows the PXRD diffractogram after subtraction of background noise. Figure 8B shows the raw PXRD data as collected.

An alternative method for the preparation of modafinil:glycolic acid co-crystals was also completed. To a solution of modafinil (1 mg, 0.0037 mmol) dissolved in a mixture of acetone and methanol (3:1, 100 microliters) was added glycolic acid (0.28 mg, 0.0037 mmol) dissolved in methanol (50 microliters). The solvent was then evaporated to dryness under a flow of nitrogen to give a mixture of the two starting components. Acetone (200 microliters) was then added to the mixture and it was heated to 70 degrees C and maintained at 70 degrees C for 2 hours. The sample was then cooled to 5 degrees C and maintained at that temperature for 1 day. After 1 day, the cap was removed from the vial and the solvent was evaporated to dryness to give a modafinil:glycolic acid co-crystal as a colorless solid. The modafinil:glycolic acid co-crystal was characterized by PXRD. The modafinil:glycolic acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 8A including, but not limited to, 9.51, 14.91, 15.97, 19.01, 20.03, 21.59, 22.75, 25.03, and 25.71 degrees 2-theta. The modafinil:glycolic acid co-crystal can, likewise, be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 8B including, but not limited to, 9.53, 14.93, 15.99, 19.05, 20.05, 21.61, 22.77, and 25.05 degrees 2-theta.

### Example 3

#### Racemic Modafinil:Maleic acid Co-crystal

Using a 250 mg/ml racemic modafinil in acetic acid solution, maleic acid was dissolved on a hotplate (about 67 degrees C) at a 2:1 modafinil to maleic acid ratio. The mixture was dried under flowing nitrogen overnight. A clear amorphous material remained. Solids began to grow after 2 days stored in a sealed vial at room temperature.

The resulting solid was characterized using PXRD (See Figures 9A and 9B). Figure 9A shows the PXRD diffractogram after subtraction of background noise. Figure 9B shows the raw PXRD data. PXRD data for the modafinil:maleic acid co-crystal are listed in Table IV. The modafinil:maleic acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 9A including, but not limited to, 4.69, 6.15, 9.61, 10.23, 15.65, 16.53, 17.19, 18.01, 19.97, 21.83, and 22.45 degrees 2-theta. The modafinil:maleic acid co-crystal can, likewise, be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 9B including, but not limited to, 4.69, 6.17, 9.63, 10.25, 15.67, 16.53, 17.21, 18.05, 19.99, 21.85, and 22.47 degrees 2-theta.

#### Example 4

##### Racemic Modafinil:L-tartaric acid Co-crystal

A modafinil:L-tartaric acid co-crystal was prepared by mixing 10.12 mg of racemic modafinil and 5.83 mg of L-tartaric acid in 2 mL of methanol. All solids were dissolved at room temperature. The solution was then left to evaporate in air. The clear and viscous material was dried further under flowing nitrogen for 2 days, and then capped. After 6 days, a small amount of white solid formed. 1 day after the first solids are seen approximately 60 % of the remaining clear amorphous volume converted to the solid form. A sample of this material was analyzed by PXRD (See Figure 10). The modafinil:L-tartaric acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 10 including, but not limited to, 6.10, 7.36, 9.38, 14.33, 16.93, 17.98, 18.81, 20.15, 20.71, 22.49, and 25.04 degrees 2-theta.

#### Example 5

##### Racemic Modafinil:Citric acid Co-crystal

Racemic modafinil (25.3 mg, 93  $\mu$ mol) and citric acid monohydrate (26.8 mg, 128  $\mu$ mol) were ground together for 3 minutes. 1 mg of the resulting mixture was then dissolved in acetone (100 microliters) and heated to 70 degrees C and maintained at that temperature for 2 hours. The solution was then cooled to 5 degrees C and was left at that

temperature for 2 days. After 2 days the cap was removed from the vial and one drop of water was added. The solvent was then evaporated to give a modafinil: citric acid monohydrate co-crystal as a colorless solid. The modafinil: citric acid monohydrate co-crystal was characterized by PXRD (See Figure 11, background subtracted). The modafinil: citric acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 11 including, but not limited to, 5.29, 7.29, 9.31, 12.41, 13.29, 17.29, 17.97, 18.79, 21.37, and 23.01 degrees 2-theta.

Other methods were also used to prepare the modafinil: citric acid monohydrate co-crystal. A second preparation was performed by placing equimolar amounts of modafinil (30 mg, 0.0001 mol) and citric acid monohydrate in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized using PXRD and DSC. In yet another preparation of the modafinil: citric acid monohydrate co-crystal, the second preparation above was completed without the addition of solvent. All of the above methods with citric acid monohydrate were shown to yield the same co-crystal via PXRD and DSC analysis.

#### Example 6

##### Racemic Modafinil: Succinic acid Co-crystal

Racemic modafinil (25mg, 90  $\mu$ mol) and succinic acid (10.6 mg, 90  $\mu$ mol) were placed in a glass vial and dissolved in methanol (20 microliters). The resulting solution was heated at 70 degrees C for 2 hours and then cooled to 5 degrees C and maintained at that temperature for 2 days. After 2 days, the cap was removed from the vial and the solvent was evaporated at 65 degrees C to give a 2:1 modafinil: succinic acid co-crystal as a colorless solid. The co-crystal is a 2:1 co-crystal comprising two moles of modafinil for every mole of succinic acid. The modafinil: succinic acid co-crystal was characterized by PXRD and DSC. (See Figures 12A, 12B, and 13) Figure 12A shows the PXRD diffractogram after subtraction of background noise. Figure 12B shows the raw PXRD data. Figure 13 shows the DSC thermogram.

An alternative method for the preparation of modafinil:succinic acid co-crystals was also completed. 49.7 mg of modafinil and 21.6 mg of succinic acid was charged to a round bottom flask to make a 1:1 mixture. Add 1.5 mL of methanol and dissolve at 65 degrees C using a hot water bath. Seed crystals of modafinil:succinic acid co-crystal from the above preparation were added to the flask. The methanol was then evaporated using a rotary evaporator and a 65 degrees C hot water bath. PXRD of the collected solid confirms the synthesis of the modafinil:succinic acid co-crystal. The modafinil:succinic acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 12A including, but not limited to, 5.45, 9.93, 15.85, 17.97, 18.73, 19.95, 21.33, 21.93, 23.01, and 25.11 degrees 2-theta. The modafinil:succinic acid co-crystal can, likewise, be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 12B including, but not limited to, 5.45, 9.93, 15.87, 17.99, 18.75, 19.95, 21.95, 23.03, and 25.07 degrees 2-theta. Single crystal data of the modafinil:succinic acid co-crystal were acquired and are reported below. Figure 14 shows a packing diagram of the modafinil:succinic acid co-crystal.

Crystal data:  $C_{17}H_{18}NO_4S$ , triclinic P-1;  $a = 5.672(4)$  angstroms,  $b = 8.719(6)$  angstroms,  $c = 16.191(11)$  angstroms,  $\alpha = 93.807(14)$  degrees,  $\beta = 96.471(17)$  degrees,  $\gamma = 92.513(13)$  degrees,  $T = 100(2)$  K,  $Z = 2$ ,  $D_c = 1.392$  Mg/m<sup>3</sup>,  $U = 792.8(9)$  cubic angstroms,  $\lambda = 0.71073$  angstroms, 2448 reflections measured, 1961 unique ( $R_{int} = 0.0740$ ). Final residuals were  $R_1 = 0.1008$ ,  $wR_2 = 0.2283$  for  $I > 2\sigma(I)$ , and  $R_1 = 0.1593$ ,  $wR_2 = 0.2614$  for all 1961 data.

A third method was also used to prepare the modafinil:succinic acid co-crystal. This method was performed by placing equimolar amounts of modafinil (30 mg, 0.0001 mol) and succinic acid in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized using PXRD and DSC. All of the above methods with succinic acid were shown to yield the same co-crystal via PXRD and DSC analysis.



#### Example 7

##### Racemic Modafinil:DL-tartaric acid Co-crystal

A suspension of racemic modafinil (162 mg; 0.591 mmol) and DL-tartaric acid (462 mg; 3.08 mmol) in acetone (10 mL) was heated to reflux for 1 minute. The undissolved DL-tartaric acid was filtered off while the suspension was still hot through a 0.2 micrometer PTFE filter. The remaining solution was allowed to cool to room temperature then to 0 degrees C for 1 hour. After 1 hour, large colorless crystals were observed. The mother liquor was decanted and the solid was allowed to air dry. The modafinil:DL-tartaric acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 15 including, but not limited to, 4.75, 9.53, 10.07, 15.83, 17.61, 19.37, 20.25, 21.53, 22.55, and 23.75 degrees 2-theta (as collected).

#### Example 8

##### Racemic Modafinil:Fumaric acid Co-crystal (Form I)

Equimolar amounts of racemic modafinil (30 mg, 0.0001 mol) and fumaric acid were placed in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized as modafinil:fumaric acid co-crystal (Form I) using PXRD (See Figure 16). The co-crystal is a 2:1 co-crystal comprising two moles of modafinil for every mole of fumaric acid. The modafinil:fumaric acid co-crystal (Form I) can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 16 including, but not limited to, 5.45, 9.95, 10.91, 15.93, 18.03, 18.81, 19.93, 20.25, 21.37, 21.95, 23.09, and 25.01 degrees 2-theta (as collected). Single crystal data of the modafinil:fumaric acid co-crystal (Form I) were acquired and are reported below. Figure 17 shows a packing diagram of the modafinil:fumaric acid co-crystal (Form I).

Crystal data:  $C_{17}H_{17}NO_4S$ ,  $M = 331.38$ , triclinic P-1;  $a = 5.7000(15)$  angstroms,  $b = 8.735(2)$  angstroms,  $c = 16.204(4)$  angstroms,  $\alpha = 93.972(6)$  degrees,  $\beta = 97.024(6)$  degrees,  $\gamma = 93.119(7)$  degrees,  $T = 100(2)$  K,  $Z = 2$ ,  $D_c = 1.381$  Mg/m<sup>3</sup>,  $U = 797.2(4)$  cubic angstroms,  $\lambda = 0.71073$  angstroms, 4047 reflections measured, 2615

unique ( $R_{\text{int}} = 0.0475$ ). Final residuals were  $R_1 = 0.0784$ ,  $wR_2 = 0.1584$  for  $I > 2\sigma(I)$ , and  $R_1 = 0.1154$ ,  $wR_2 = 0.1821$  for all 2615 data.

#### Example 9

##### Racemic Modafinil:Fumaric acid Co-crystal (Form II)

Equimolar amounts of racemic modafinil (30 mg, 0.0001 mol) and fumaric acid were placed in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized as modafinil:fumaric acid co-crystal (Form II) using PXRD (See Figure 18). The modafinil:fumaric acid co-crystal (Form II) can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 18 including, but not limited to, 6.47, 8.57, 9.99, 13.89, 14.53, 16.45, 17.13, 17.51, 18.39, 20.05, 20.79, 25.93, and 27.95 degrees 2-theta (as collected).

#### Example 10

##### Racemic Modafinil:Gentisic acid Co-crystal

Equimolar amounts of racemic modafinil (30 mg, 0.0001 mol) and gentisic acid were placed in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized using PXRD (See Figure 19). The modafinil:gentisic acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 19 including, but not limited to, 6.96, 12.92, 14.76, 17.40, 18.26, 20.10, 20.94, 23.46, and 24.36 degrees 2-theta (as collected).

#### Example 11

##### Racemic Modafinil:Oxalic acid Co-crystal

A preparation of modafinil:oxalic acid co-crystal was performed by placing equimolar amounts of racemic modafinil (30 mg, 0.0001 mol) and oxalic acid in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then

placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized using PXRD (See Figure 20). In another preparation of the modafinil:oxalic acid co-crystal, the preparation above was completed without the addition of solvent. Both methods were shown to yield the same co-crystal via PXRD analysis. The modafinil:oxalic acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 20 including, but not limited to, 5.98, 13.68, 14.80, 17.54, 19.68, 21.12, 21.86, and 28.90 degrees 2-theta (as collected).

#### Example 12

##### Racemic Modafinil:1-hydroxy-2-naphthoic acid Co-crystal

Racemic modafinil (30 mg, 0.0001 mol) and 1-hydroxy-2-naphthoic acid (21 mg, 0.0001 mol) were placed in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized using PXRD (See Figure 21). The modafinil:1-hydroxy-2-naphthoic acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 21 including, but not limited to, 5.72, 7.10, 11.48, 14.16, 15.66, 17.92, 19.18, 20.26, 21.28, 21.94, 24.38, and 26.86 degrees 2-theta (as collected).

#### Example 13

##### R-(-)-Modafinil:Malonic acid Co-crystal

R-(-)-modafinil:malonic acid co-crystal was prepared by grinding R-(-)-modafinil (29.7 mg, 0.109 mmol) with malonic acid (11.9 mg, 0.114 mmol). The ground mixture was then heated to 80 degrees C for 10 minutes. The powder was analyzed by PXRD and DSC (See Figures 22 and 23, respectively). The PXRD pattern confirms that the co-crystal was made and shows many similarities to the PXRD pattern for the racemic modafinil:malonic acid co-crystal. The R-(-)-modafinil:malonic acid co-crystal can be

characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 22 including, but not limited to, 5.04, 9.26, 16.73, 18.23, 19.37, 21.90, 22.74, 24.44, and 25.67 degrees 2-theta (data as collected). The DSC showed a melting peak at 111.59 degrees C with a heat of fusion of 112.9 J/g.

#### Example 14

##### R-(-)-Modafinil:Succinic acid Co-crystal

R-(-)-modafinil:succinic acid co-crystal was prepared by grinding R-(-)-modafinil (30.9 mg, 0.113 mmol) with succinic acid (14.8 mg, 0.125 mmol). The ground mixture was then heated to 145 degrees C for 5 minutes. The powder was analyzed by PXRD and DSC (See Figures 24 and 25, respectively). The PXRD pattern confirms that the co-crystal was made and shows many similarities to the PXRD pattern for the racemic modafinil:succinic acid co-crystal made from solution. The R-(-)-modafinil:succinic acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 24 including, but not limited to, 5.36, 9.83, 15.80, 17.88, 18.70, 19.87, 21.21, 21.85, and 25.96 degrees 2-theta (data as collected). The DSC showed a melting peak at 143.4 degrees C with a heat of fusion of 140.7 J/g.

#### Example 15

##### R-(-)-Modafinil:Citric acid Co-crystal

R-(-)-modafinil: citric acid co-crystal was prepared by grinding R-(-)-modafinil (30.0 mg, 0.110 mmol) with citric acid monohydrate (27.1 mg, 0.129 mmol). The powder was analyzed by PXRD and DSC (See Figures 26 and 27, respectively). The PXRD pattern confirms that the co-crystal was made and shows many similarities to the PXRD pattern for the racemic modafinil: citric acid co-crystal. The R-(-)-modafinil: citric acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 26 including, but not limited to, 5.18, 7.23, 9.23, 12.32, 13.23, 17.25, 17.92, 18.76, 20.25, 21.30, and 23.71 degrees 2-theta (data as collected). The DSC showed a melting peak at 111.59 degrees C with a heat of fusion of 112.9 J/g.

#### Example 16

##### R-(-)-Modafinil:DL-tartaric acid Co-crystal

Equimolar amounts of R-(-)-modafinil (30 mg, 0.0001 mol) and DL-tartaric acid were placed in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized using PXRD and DSC (See Figures 28 and 29, respectively). The R-(-)-modafinil:DL-tartaric acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 28 including, but not limited to, 4.67, 15.41, 17.97, 19.46, 20.50, 22.91, and 24.63 degrees 2-theta (as collected). Endothermic transitions were present at about 107, 152, and 187 degrees C.

#### Example 17

##### R-(-)-Modafinil:1-hydroxy-2-naphthoic acid Co-crystal

Equimolar amounts of R-(-)-modafinil (30 mg, 0.0001 mol) and 1-hydroxy-2-naphthoic acid were placed in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized using PXRD and DSC (See Figures 30 and 31, respectively). The R-(-)-modafinil:1-hydroxy-2-naphthoic acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 30 including, but not limited to, 5.31, 8.95, 10.68, 12.15, 14.48, 21.27, 23.15, 24.50, 25.52, and 26.72 degrees 2-theta (as collected). Endothermic transitions were present at about 118 and 179 degrees C.

#### Example 18

##### R-(-)-Modafinil:Lauric acid Co-crystal

Equimolar amounts of R-(-)-modafinil (30 mg, 0.0001 mol) and lauric acid were placed in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized using PXRD and DSC (See Figures 32 (bottom pattern) and 33, respectively). The R-(-)-modafinil:lauric acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 32 including, but not limited to, 3.15, 7.17, 9.50, 10.25, 12.08, 14.30, 17.67, 19.14, 20.14, 21.43, 23.84, and 25.77 degrees 2-theta (as collected). Endothermic transitions were present at about 141 and 155 degrees C.

#### Example 19

##### R-(-)-Modafinil:Orotic acid Co-crystal

Equimolar amounts of R-(-)-modafinil (30 mg, 0.0001 mol) and orotic acid were placed in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized using PXRD and DSC (See Figures 34 and 35, respectively). The R-(-)-modafinil:orotic acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 34 including, but not limited to, 9.77, 14.61, 17.85, 20.52, 20.95, 24.03, 26.80, and 28.60 degrees 2-theta (as collected). Endothermic transitions were present at about 116, 130, and 169 degrees C.

Table IV: Co-crystals of Modafinil

Co-Crystal former	Representative PXRD Peaks (degrees 2-theta)
Malonic acid	5.00, 9.17, 10.08, 16.81, 18.26, 19.43, 21.36, 21.94, 22.77, 24.49, 25.63, 26.37, 28.45
Glycolic acid	9.53, 14.93, 15.99, 19.05, 20.05, 21.61, 22.77, 25.05
Maleic acid	4.69, 6.17, 9.63, 10.25, 15.67, 16.53, 17.21, 18.05, 19.99, 21.85, 22.47
L-tartaric acid	6.10, 7.36, 9.38, 14.33, 16.93, 17.98, 18.81, 20.15, 20.71, 22.49, 25.04
Citric acid	5.29, 7.29, 9.31, 12.41, 13.29, 17.29, 17.97, 18.79, 21.37, 23.01
Succinic acid	5.45, 9.93, 15.87, 17.99, 18.75, 19.95, 21.95, 23.03, 25.07
DL-tartaric acid	4.75, 9.53, 10.07, 15.83, 17.61, 19.37, 20.25, 21.53, 22.55, 23.75

Fumaric acid (Form I)	5.45, 9.95, 10.91, 15.93, 18.03, 18.81, 19.93, 20.25, 21.37, 21.95, 23.09, 25.01
Fumaric acid (Form II)	6.47, 8.57, 9.99, 13.89, 14.53, 16.45, 17.13, 17.51, 18.39, 20.05, 20.79, 25.93, 27.95
Gentisic acid	6.96, 12.92, 14.76, 17.40, 18.26, 20.10, 20.94, 23.46, 24.36
Oxalic acid	5.98, 13.68, 14.80, 17.54, 19.68, 21.12, 21.86, 28.90
1-hydroxy-2-naphthoic acid	5.72, 7.10, 11.48, 14.16, 15.66, 17.92, 19.18, 20.26, 21.28, 21.94, 24.38, 26.86
*Malonic acid	5.04, 9.26, 16.73, 18.23, 19.37, 21.90, 22.74, 24.44, 25.67
*Succinic acid	5.36, 9.83, 15.80, 17.88, 18.70, 19.87, 21.21, 21.85, 25.96
*Citric acid	5.18, 7.23, 9.23, 12.32, 13.23, 17.25, 17.92, 18.76, 20.25, 21.30, 23.71
*DL-tartaric acid	4.67, 15.41, 17.97, 19.46, 20.50, 22.91, 24.63
*1-hydroxy-2-naphthoic acid	5.31, 8.95, 10.68, 12.15, 14.48, 21.27, 23.15, 24.50, 25.52, 26.72
*Lauric acid	3.15, 7.17, 9.50, 10.25, 12.08, 14.30, 17.67, 19.14, 20.14, 21.43, 23.84, 25.77
*Orotic acid	9.77, 14.61, 17.85, 20.52, 20.95, 24.03, 26.80, 28.60
*Gentisic acid	7.07, 7.51, 9.07, 12.31, 16.03, 17.63, 18.39, 19.83, 21.27, 23.57, 26.93, 28.85

\* = API is R-(-)-modafinil, all other co-crystals comprise racemic modafinil

#### Example 20

##### Acetic acid Solvate of Racemic Modafinil

12.9 mg racemic modafinil was mixed with 40 microliters acetic acid. The mixture was heated at 50 degrees C to completely dissolve the solid. The solution was allowed to cool to room temperature, and left overnight, which yielded no precipitation. The solution was then evaporated under flowing nitrogen until precipitation was observed. The resulting solid was further dried under flowing nitrogen. Characterization of the product has been achieved via PXRD, TGA, DSC, and Raman spectroscopy. (See Figures 36-39, respectively) An alternative method for the preparation of the acetic acid solvate of modafinil was also completed. A sample of modafinil acetic acid solvate was prepared by dissolving 12.9 mg of the compound in 40 microliters acetic acid incubating at 65 degrees C for 30 minutes to dissolve, then cooling to 25 degrees C to incubate overnight. The sample was then evaporated to approximately 1/3 volume. After centrifugation of the sample, rapid nucleation and growth of crystals was observed. An additional 20 microliters of acetic acid was then added. The sample was heated at 50 degrees C until partial dissolution of the crystals was observed. The sample was then cooled to room temperature over a 1 hour period, then to 5 degrees C for 3 hours in an attempt to induce crystal growth. The sample was then dried under nitrogen gas. Rapid appearance of crystals was observed. The modafinil acetic acid solvate can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 36

including, but not limited to, 6.17, 9.63, 15.69, 17.97, 19.99, and 21.83 degrees 2-theta (data as collected).

#### Example 21

##### Tetrahydrofuran Solvate of Racemic Modafinil

The tetrahydrofuran (THF) solvate of modafinil was prepared by placing 10.4 mg of racemic modafinil in 1 mL of tetrahydrofuran. The powder submerged in the tetrahydrofuran did not completely dissolve and was observed to convert, overnight, into long, fine, needle shaped crystals which were collected and analyzed by PXRD (See Figure 40). The modafinil tetrahydrofuran solvate can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 40 including, but not limited to, 6.97, 9.79, 10.97, 16.19, 19.03, 19.71, 20.59, 22.25, and 25.13 degrees 2-theta (data as collected).

#### Example 22

##### 1,4-Dioxane Solvate of Racemic Modafinil

The 1,4-dioxane solvate of modafinil was prepared by placing 11.6 mg of racemic modafinil in 1 mL of 1,4-dioxane. The powder submerged in the 1,4-dioxane was observed to convert, overnight, into long fine needle shaped crystals which were collected and analyzed by PXRD (See Figure 41). The modafinil 1,4-dioxane solvate can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 41 including, but not limited to, 6.93, 9.85, 10.97, 16.19, 18.97, 19.61, 20.33, 20.65, and 22.07 degrees 2-theta (data as collected).

#### Example 23

##### Methanol Solvate of Racemic Modafinil

The methanol solvate of modafinil is obtained by evaporating 2 mL of a 30 mg/mL racemic modafinil solution in methanol under flowing nitrogen overnight. The methanol solvate was characterized by PXRD, TGA, and DSC (See Figures 42, 43, and 44, respectively). The modafinil methanol solvate can be characterized by any one, any



two, any three, any four, any five, or any six or more of the peaks in Figure 42 including, but not limited to, 6.15, 9.89, 12.25, 15.69, 17.97, 20.07, 21.85, and 22.73 degrees 2-theta (data as collected).

#### Example 24

##### Nitromethane Solvate of Racemic Modafinil

The nitromethane solvate of modafinil was prepared by placing 12.9 mg of racemic modafinil in 1 mL of nitromethane. The powder submerged in the nitromethane did not completely dissolve and was observed to coarsen, overnight, forming large rectangular crystals. The solid was collected and analyzed by PXRD (See Figure 45).

The modafinil nitromethane solvate can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 45 including, but not limited to, 6.17, 9.77, 15.89, 18.11, 20.07, 22.17, 22.91, 25.31, and 25.83 degrees 2-theta (data as collected).

#### Example 25

##### Acetone Solvate of Racemic Modafinil

Equimolar amounts of racemic modafinil (30 mg, 0.0001 mol) and glutaric acid were placed in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized using PXRD (See Figure 46). The resulting material was characterized as an acetone solvate of modafinil. The acetone solvate of modafinil can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 46 including, but not limited to, 6.11, 9.53, 15.81, 18.11, 20.03, 21.63, 22.45, 25.23, 25.65, 28.85, 30.23, and 32.93 degrees 2-theta (as collected). The acetone solvate may also be obtained following the procedure above with several other co-crystal formers including adipic acid, lactobionic acid, maleic acid, and glycolic acid.

#### Example 26

Racemic modafinil (1 mg, 0.0037mmol) and mandelic acid (0.55 mg, 0.0037 mmol) were dissolved in acetone (400 microliters). The solution was allowed to evaporate to dryness and the resulting solid was characterized using PXRD (See Figure 47). The obtained solid may be a solvate of modafinil. The form can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 47 including, but not limited to, 6.11, 9.53, 14.77, 15.77, 18.03, 20.01, and 21.61 degrees 2-theta (background removed).

#### Example 27

Racemic modafinil (1 mg, 0.0037mmol) and fumaric acid (0.42 mg, 0.0037 mmol) were dissolved in 1,2-dichloroethane (400 microliters). The solution was allowed to evaporate to dryness and the resulting solid was characterized using PXRD (See Figure 48). The obtained solid may be a solvate of modafinil. The form can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 48 including, but not limited to, 5.87, 8.95, 12.49, 13.99, 18.19, 19.99, 21.57, and 25.01 degrees 2-theta (background removed).

#### Example 28

##### Polymorph of Racemic Modafinil

Racemic modafinil was dispensed from a stock solution containing 50 mg of modafinil in 20 mL of a 15:5 acetone/methanol mixture. The solution was then evaporated to dryness under a flow of nitrogen. Mandelic acid was dispensed from an acetone solution and the mixture was again evaporated to dryness. 200 microliters of acetone was then added and the vials were capped. After standing at room temperature for one day, the caps were removed and the solvent was allowed to evaporate. PXRD was carried out on the sample (See Figure 49). The modafinil polymorph is denoted as form VII. The polymorph (form VII) can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 49 including, but not limited to, 5.47, 9.99, 15.73, 17.85, 18.77, 20.05, 21.23, 22.05, 23.15, and 25.13 degrees 2-theta (data as collected).

### Example 29

#### Racemic Modafinil:Malonic acid Co-Crystal Pharmacokinetic Study in Dogs

The racemic modafinil:malonic acid co-crystal (from Example 1) was administered to dogs in a pharmacokinetic study. Particles of modafinil:malonic acid co-crystal with a median particle size of about 16 micrometers were administered in the study. As a reference, micronized modafinil with a median particle size of about 2 micrometers was also administered in the study. The AUC of the modafinil:malonic acid co-crystal was determined to be 40 to 60 percent higher than that of the pure modafinil. Such a higher bioavailability illustrates the modulation of an important pharmacokinetic parameter due to an embodiment of the present invention. A compilation of important pharmacokinetic parameters measured during the animal study are included in Table V.

Table V- Pharmacokinetic parameters of modafinil:malonic acid co-crystal and pure modafinil in dogs

Parameter	Pure Modafinil	Modafinil:malonic acid co-crystal
Median particle size	2 micrometers	16 micrometers
C <sub>max</sub> (ng/mL)	11.0 ± 5.9	10.3 ± 3.4
T <sub>max</sub> (hours)	1.3 ± 0.6	1.7 ± 0.6
AUC (relative)	1.0	1.4-1.6
Half-life (hours)	2.1 ± 0.7	5.1 ± 2.4

### Example 30

#### Racemic Modafinil:Malonic acid Co-crystal Solid-State Stability

The stability of the racemic modafinil:malonic acid co-crystal was measured at various temperatures and relative humidities over a four week period. No degradation was found to occur at 20 or 40 degrees C. At 60 degrees C, about 0.14 percent degradation per day was determined based on a simple exponential model. At 80 degrees C, about 8 percent degradation per day was determined.

The stability of the modafinil:malonic acid co-crystal was also measured at various temperatures and relative humidities over a 26 week period. Figures 50 and 51 show the % area impurities as measured via HPLC versus time (weeks) for samples stored at various conditions including: 25 degrees C, 60 % RH; 40 degrees C, 75 percent

RH; 40 degrees C, ambient RH; 60 degrees C, ambient RH; 80 degrees C, ambient RH; and -20 degrees C. These data show that the compound is stable when stored at or below 40 degrees C for at least 26 weeks. Figure 52 compares PXRD patterns of initial and 26 week old samples of the modafinil:malonic acid co-crystal for several temperatures and RH levels.

### Example 31

#### Formulation of Racemic Modafinil:Malonic Acid Co-crystal

The formulation of a racemic modafinil:malonic acid co-crystal was completed using lactose. Two mixtures, one of modafinil and lactose, and the second of modafinil:malonic acid co-crystal and lactose, were ground together in a mortar and pestle. The mixtures targeted a 1:1 weight ratio of modafinil to lactose. In the modafinil and lactose mixture, 901.2 mg of modafinil and 901.6 mg of lactose were ground together. In the modafinil:malonic acid co-crystal and lactose mixture, 1221.6 mg of co-crystal and 871.4 mg of lactose were ground together. The resulting powders were analyzed by PXRD and DSC. The PXRD patterns and DSC thermograms of the mixtures showed virtually no change upon comparison with both individual components. The DSC of the co-crystal mixture showed only the co-crystal melting peak at 113.6 degrees C with a heat of fusion of 75.9 J/g. This heat of fusion is 59.5 % of that found for the co-crystal alone (127.5 J/g). This result is consistent with a 58.4 % weight ratio of co-crystal in the mixture. The DSC of the modafinil and lactose mixture had a melting point of 165.7 degrees C. This is slightly lower than the measured melting point of modafinil (168.7 degrees C). The heat of fusion of the mixture (59.3 J/g) is 46.9 % that of the modafinil alone (126.6 J/g), which is consistent with the estimated value of 50 %.

The *in vitro* dissolution of both the modafinil:malonic acid co-crystal and pure modafinil were tested in capsules. Both gelatin and hydroxypropylmethyl cellulose (HPMC) capsules were used in the dissolution study. The capsules were formulated with and without lactose. All formulations were ground in a mortar and pestle prior to transfer into a capsule. The dissolution of the capsules was tested in 0.01 M HCl (See Figure 53).

*In 0.01N HCl, using sieved and ground materials in gelatin capsules:*

Modafinil and the modafinil:malonic acid co-crystal were passed through a 38 micrometer sieve. Gelatin capsules (Size 0, B&B Pharmaceuticals, Lot # 15-01202) were filled with 200.0 mg sieved modafinil, 280.4 mg sieved modafinil:malonic acid co-crystal, 200.2 mg ground modafinil, or 280.3 mg ground modafinil:malonic acid co-crystal. Dissolution studies were performed in a Vankel VK 7000 Benchsaver Dissolution Testing Apparatus with the VK750D heater/circulator set at 37 degrees C. At 0 minutes, the capsules were dropped into vessels containing 900 mL 0.01 M HCl and stirred by paddles.

Absorbance readings were taken using a Cary 50 Spectrophotometer (wavelength set at 260nm) at the following time points: 0, 5, 10, 15, 20, 25, 30, 40, 50, and 60 minutes. The absorbance values were compared to those of standards and the modafinil concentrations of the solutions were calculated.

*In 0.01N HCl, using ground materials in gelatin or HPMC capsules, with and without lactose:*

Modafinil and the modafinil:malonic acid co-crystal were mixed with equivalent amounts of lactose (Spectrum, Lot QV0460) for approximately 5 minutes. Gelatin capsules (Size 0, B&B Pharmaceuticals, Lot # 15-01202) were filled with 400.2 mg modafinil and lactose (approximately 200 mg modafinil), or 561.0 mg modafinil:malonic acid co-crystal and lactose (approximately 200 mg modafinil). HPMC capsules (Size 0, Shionogi, Lot # A312A6) were filled with 399.9 mg modafinil and lactose, 560.9 mg modafinil:malonic acid co-crystal and lactose, 199.9 mg modafinil, or 280.5 mg modafinil:malonic acid co-crystal. The dissolution study was carried out as described above.

### Example 32

#### In Vitro Dissolution

Figure 54 shows in vitro dissolution data of micronized racemic modafinil:malonic acid co-crystal and of micronized modafinil in simulated gastric fluid (SGF) and in simulated intestinal fluid (SIF). Both samples were blended with lactose and filled into HPMC capsules. The co-crystal releases modafinil into solution more quickly in both SGF and SIF than does the free form of modafinil. Figure 55 compares

the dissolution of an HPMC capsule filled with the modafinil:malonic acid co-crystal blended with lactose and that of a PROVIGIL tablet. Figure 56 shows a dynamic vapor sorption (DVS) isotherm plot of the modafinil:malonic acid co-crystal. This plot shows no appreciable water adsorption up to at least 40 percent RH at 26 degrees C.

### Example 33

#### In Vivo Studies

A pharmacokinetic study was completed with dogs using both racemic modafinil:malonic acid formulated with lactose and PROVIGIL tablets (200 mg). Seven capsules were filled with the modafinil:malonic acid co-crystal and lactose to 476.24 +/- 2 mg, each containing 200 mg modafinil. Figure 57 shows the co-crystal formulation has an increased  $C_{max}$  and an increased bioavailability. Several important pharmacokinetic parameters are described in Table VI. In Table VI, " $C_{max}$ " is the maximum blood plasma concentration, "AUC (inf)" is the extrapolated area under the curve, " $t_{1/2}$ " is the amount of time for the blood plasma level to decrease to half of the  $C_{max}$  level beginning at administration, " $T_{max}$ " is the time to maximum blood plasma concentration from administration, "CL" is the clearance rate of modafinil, and "F %" is the percent bioavailability.

Table VI- PK parameters of modafinil:malonic acid co-crystal and PROVIGIL from In Vivo study

PROVIGIL (200 mg)						
	$C_{max}$	AUC (inf)	$t_{1/2}$	$T_{max}$	CL	F %
Mean	7838.33	41193.33	1.76	2.00	524.17	66.48
SD	2734.35	8104.32	0.88	0.63	146.98	13.08
% CV	34.9	19.7	49.7	31.6	28.0	19.7
Modafinil:malonic acid (200 mg modafinil)						
	$C_{max}$	AUC (inf)	$t_{1/2}$	$T_{max}$	CL	F %
Mean	11246.67	50545.00	1.63	2.00	368.33	81.57
SD	1662.13	10635.46	0.64	0.89	165.60	17.16
% CV	14.8	21.0	39.5	44.7	45.0	21.0

### Example 34

#### Polymorphs of R-(-)-modafinil

Five polymorphs of R-(-)-modafinil have been observed, each characterized by PXRD. Figures 58A, 59A, 60A, and 61A show these PXRD diffractograms (data as collected) of polymorphs Form I, Form II, Form III, Form IV, and Form V.

#### R-(-)-modafinil Forms I and II

Anhydrous ammonia gas was bubbled through a solution containing R-benzhydrylsulfinyl methyl ester (8.62 g, 0.0299 mol) in methanol (125 mL) for 10 minutes. The pressure build-up from the reaction caused a back flow of sodium bicarbonate from the trap into the reaction mixture. The reaction was stopped and the precipitate was collected. The filtrate was concentrated under reduced pressure to give a yellow solid residue (2.8 g). The yellow solid was passed through a column (silica gel, grade 9385, 230-400, mesh 60 angstroms), 3:1 v/v ethyl acetate:hexane as eluent). The filtrates were then combined and concentrated under reduced pressure to give a slightly yellow solid (most of the yellow color remained on the column). The solid was then recrystallized from ethanol by heating the mixture until it was boiling and then cooling to room temperature to give R-(-)-modafinil as colorless solid (580 mg). PXRD analysis of the solid obtained indicated that the product may be a mixture of two forms, closely resembling forms I and II of racemic modafinil (See US Patent Application No. 20020043207, published on April 18, 2002).

The R-(-)-modafinil solid obtained above can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 58A including, but not limited to, 8.97, 10.15, 12.87, 14.15, 15.13, 15.77, 18.18, and 20.39 degrees 2-theta (data as collected). If the solid above is indeed a mixture of R-(-)-modafinil Forms I and II, R-(-)-modafinil form I can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 58A including, but not limited to, 8.97, 10.15, 12.87, 15.13, 15.77, 18.19, and 19.25 degrees 2-theta (data as collected). If the solid above is indeed a mixture of R-(-)-modafinil Forms I and II, R-(-)-modafinil form II can be characterized by any one, any two, any

three, any four, any five, or any six or more of the peaks in Figure 58A including, but not limited to, 8.97, 10.15, 14.15, 15.13, 17.41, and 18.19 degrees 2-theta (data as collected).

DSC of the solid described above showed a melting point of about 167 degrees C as determined by DSC (See Figure 58B).

#### R-(-)-modafinil Form III

Anhydrous ammonia gas was bubbled through a solution containing R-benzhydrylsulfinyl methyl ester (8.3 g, 0.0288 mol) in methanol (75 mL) for 10 minutes. The reaction was then stirred in a 5 degrees C ice bath for 1 hour and ammonia gas was bubbled through for an additional 10 minutes. Stirring was continued for an additional 2 hours and ammonia was bubbled through again for 10 minutes. After stirring for another hour a precipitate had formed (575 mg) and was collected. The filtrate was then neutralized using conc. HCl and another precipitate formed and was collected. The solid residue was then re-crystallized from a 1:1 v/v mixture of ethanol and isopropyl alcohol by heating the mixture until it was boiling and then cooling to room temperature to give R-(-)-modafinil form III as a colorless solid (1.01 g).

R-(-)-modafinil Form III can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 59A including, but not limited to, 7.21, 10.37, 17.73, 19.23, 21.17, 21.77 and 23.21 degrees 2-theta (Rigaku PXRD, data as collected).

DSC of the R-(-)-modafinil form III characterized in Figure 59B shows a melting point of about 161 degrees C.

A second batch of R-(-)-modafinil form III was prepared for further analysis via thermal microscopy and PXRD. Solubility data was also acquired. These data are discussed below.

R-(-)-modafinil Form III solubility was equal to about 6.1-7.0 mg/mL. The solubility was measured from an isopropyl acetate slurry stirred at 25 degrees C. The solubility measurement was performed via HPLC. The solid from the solubility samples were dried under nitrogen and characterized by PXRD and thermal microscopy. Form conversion was not observed during procedure.



Thermal (hotstage) microscopy was used with a heating rate of 10 degrees C/minute to measure the melting point of R-(-)-modafinil Form III, which was determined to be about 156-158 degrees C.

R-(-)-modafinil Form III can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 59C including, but not limited to, 7.19, 10.37, 12.11, 14.41, 17.73, 19.17, 21.71, 23.17, 24.39, 25.17, 26.07, and 27.91 degrees 2-theta (Rigaku PXRD, data with background removed).

#### R-(-)-modafinil Form IV

Anhydrous ammonia gas was bubbled through a solution containing R-benzhydrylsulfinyl methyl ester (8.3 g, 0.0288 mol) in methanol (75 mL) for 10 minutes. The reaction was then stirred in a 5 degrees C ice bath for 1 hour and ammonia gas was bubbled through for an additional 10 minutes. Stirring was continued for an additional 4 hours. After stirring for another hour a precipitate had formed (422 mg) and was collected. The filtrate was then neutralized using conc. HCl and another precipitate formed and was collected. The solid material (3 g) was passed through a column (silica gel, grade 9385, 230-400, mesh 60 angstroms), 3:1 v/v ethyl acetate and hexane as eluent). The column was then flushed with ethyl acetate (250 mL). The filtrates were combined and concentrated under reduced pressure to give R-(-)-modafinil form IV as a colorless solid (590 mg).

R-(-)-modafinil Form IV can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 60A including, but not limited to, 7.79, 10.31, 11.77, 16.49, 17.33, 19.47, and 23.51 degrees 2-theta (Rigaku PXRD, data as collected).

DSC of the R-(-)-modafinil form IV characterized in Figure 60B showed a melting point of about 147 degrees C.

A second batch of R-(-)-modafinil form IV was prepared for further analysis via thermal microscopy and PXRD. Solubility data was also acquired. These data are discussed below.

R-(-)-modafinil Form IV solubility was equal to about 3.5-4.0 mg/mL. The solubility was measured from an isopropyl acetate slurry stirred at 25 degrees C. The

solubility measurement was performed via HPLC. The solid from the solubility samples were dried under nitrogen and characterized by PXRD and thermal microscopy. Form conversion was not observed during procedure.

Thermal (hotstage) microscopy was used with a heating rate of 10 degrees C/minute to measure the melting point of R-(-)-modafinil Form IV, which was determined to be about 147-158 degrees C.

R-(-)-modafinil Form IV can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 60C including, but not limited to, 7.77, 10.33, 11.75, 16.53, 19.43, 19.89, 21.87, 23.49, and 26.69 degrees 2-theta (Rigaku PXRD, data with background removed).

#### R-(-)-modafinil Form V

R-(-)-modafinil form IV (prepared in procedure above) was heated in a solution of 1:1 v/v ethyl acetate:ethanol until the mixture was boiling and then was cooled to room temperature. The solid material was then collected and characterized as R-(-)-modafinil form V.

R-(-)-modafinil Form V can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 61A including, but not limited to, 6.61, 10.39, 13.99, 16.49, 17.73, 19.03, 20.87 and 22.31 degrees 2-theta (Rigaku PXRD, data as collected).

A second batch of R-(-)-modafinil form V was prepared for further analysis via thermal microscopy and PXRD. Solubility data was also acquired. These data are discussed below.

R-(-)-modafinil Form V solubility was equal to about 2.1-2.6 mg/mL. The solubility was measured from an isopropyl acetate slurry stirred at 25 degrees C. The solubility measurement was performed via HPLC. The solid from the solubility samples were dried under nitrogen and characterized by PXRD and thermal microscopy. Form conversion was not observed during procedure.

Thermal (hotstage) microscopy was used with a heating rate of 10 degrees C/minute to measure the melting point of R-(-)-modafinil form V, which was determined to be about 159 degrees C.

R-(-)-modafinil Form V can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 61B including, but not limited to, 6.53, 10.19, 13.90, 16.56, 17.35, 17.62, 18.99, 20.93, 22.08, 23.36, and 25.91 degrees 2-theta (Bruker PXRD, data as collected).

The polymorphs of R-(-)-modafinil are named Forms I, II, III, IV, and V based on similarities in the PXRD diffractograms to those found in the diffractograms for corresponding racemic modafinil Forms I, II, III, IV, and V in US Patent Application No. 20020043207, published on April 18, 2002.

#### Example 35

##### R-(-)-modafinil:Gentisic acid Co-crystal

Equimolar amounts of R-(-)-modafinil (30 mg, 0.0001 mol) and gentisic acid were placed in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid mixture was milled for 5 minutes. The resultant powder was then collected and characterized using PXRD (See Figure 62). The R-(-)-modafinil:gentisic acid co-crystal can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 62 including, but not limited to, 7.07, 7.51, 9.07, 12.31, 16.03, 17.63, 18.39, 19.83, 21.27, 23.57, 26.93, and 28.85 degrees 2-theta (as collected).

#### Example 36

##### Channel Solvates of Racemic Modafinil

Channel solvates of modafinil have been unexpectedly discovered. Equimolar amounts of racemic modafinil (30 mg, 0.0001 mol) and 1-hydroxy-2-naphthoic acid were placed in a stainless steel vial. 20 microliters of acetone was added to the vial. The vial was then placed in a grinder (wig-l-bug, Bratt Technologies, 115V/60Hz) and the solid

mixture was milled for 5 minutes. The resultant powder was then collected and characterized. The resulting material was characterized as an acetone channel solvate of modafinil. Single-crystal x-ray parameters:  $P2(1)/n$ ,  $a = 12.737(3)$  angstroms,  $b = 5.5945(11)$  angstroms,  $c = 22.392(5)$  angstroms,  $\alpha = 90$  degrees,  $\beta = 104.140(4)$  degrees,  $\gamma = 90$  degrees,  $V = 1547.3(5)$  cubic angstroms,  $Z = 2$ . Figures 63 and 64 show packing diagrams of the acetone channel solvate of modafinil. The packing diagrams show acetone with a variable position within the channel structure. An ethyl acetate channel solvate has also been prepared according to the method above using ethyl acetate in place of acetone.

#### Example 37

##### *o*-Xylene Hemisolvate of Racemic Modafinil

An *o*-xylene hemisolvate was formed by preparing a 1:2 solution of racemic modafinil (49.6 mg, 0.181 mmol) and 1-hydroxy-2-napthoic acid (68.3 mg, 0.363 mmol) in *o*-xylene (4.5 mL). The mixture was heated on a hotplate with swirling until all solids were dissolved. The solution was then left to crystallize in a sealed vial. The resulting powder was collected in a centrifuge filter and analyzed by PXRD (Figure 65), Raman spectroscopy (Figure 66), TGA (Figure 67), and DSC (Figure 68). The *o*-xylene solvate can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 65 including, but not limited to, 5.31, 6.53, 6.96, 10.68, 14.20, 17.64, 19.93, 25.69, and 26.79 degrees 2-theta. The *o*-xylene solvate can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 66 (middle spectrum) including, but not limited to, 1641, 1407, 1379, 1211, 1024, and 721  $\text{cm}^{-1}$ .

#### Example 38

##### Benzene Hemisolvate of Racemic Modafinil

A benzene hemisolvate was formed by preparing a 1:2 solution of racemic modafinil (50.6 mg, 0.181 mmol) and 1-hydroxy-2-napthoic acid (70.1 mg, 0.373 mmol)

in benzene (1.8 mL). The mixture was heated on a hotplate with swirling until all solids were dissolved. The solution was then left to crystallize in a sealed vial. The resulting powder was collected in a centrifuge filter and analyzed by PXRD (Figure 69), Raman spectroscopy (Figure 70), TGA (Figure 71), and DSC (Figure 72). The benzene solvate can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 69 including, but not limited to, 5.82, 6.09, 8.11, 10.28, 12.06, 13.28, 14.73, 17.03, 19.11, 19.93, 21.23, 25.38, and 26.43 degrees 2-theta. The benzene solvate can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 70 (middle spectrum) including, but not limited to, 1637, 1600, 1409, 1380, 1214, 1025, 998, and 721  $\text{cm}^{-1}$ .

#### Example 39

##### Toluene Hemisolvate of Racemic Modafinil

A toluene hemisolvate was formed by making a 1:2 solution of racemic modafinil (37.3 mg, 0.136 mmol) and 1-hydroxy-2-naphthoic acid (51.3 mg, 0.273 mmol) in toluene (1 mL). The mixture was heated on a hotplate with swirling until all solids were dissolved. The solution was then left to crystallize in a sealed vial. The resulting powder was collected in a centrifuge filter and analyzed by PXRD (Figure 73), Raman spectroscopy (Figure 74), TGA (Figure 75), and DSC (Figure 76). The toluene solvate can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 73 including, but not limited to, 5.30, 5.96, 10.65, 12.90, 14.51, 17.60, and 18.15 degrees 2-theta. The toluene solvate can be characterized by any one, any two, any three, any four, any five, or any six or more of the peaks in Figure 74 (middle spectrum) including, but not limited to, 1640, 1581, 1408, 1380, 1209, 1024, 1001, and 722  $\text{cm}^{-1}$ .

#### Example 40

##### Pharmacokinetics of Isomers of Modafinil

A dog pharmacokinetic study (N = 6) of a single intravenous dose of R-(-)-modafinil was completed. The purity of the R-(-)-modafinil in the administered

formulation was ca 80 percent. This formulation was compared to a formulation of racemic modafinil, also administered by the intravenous route to the same dogs in a crossover design. Results are reported in Table VII. In Table VII, " $C_{max}$ " is the maximum blood plasma concentration, "AUC (inf)" is the extrapolated area under the curve, " $t_{1/2}$ " is the amount of time for the blood plasma level to decrease to half of the  $C_{max}$  level beginning at administration, " $V_d$ " is the volume of distribution, and "CL" is the clearance rate of modafinil.

Table VII- PK parameters of racemic modafinil and R-(-)-modafinil from In Vivo study

Racemic Modafinil (5 mg/kg IV)					
	$C_{max}$ (ng/mL)	AUC (inf) (ng/mL x hr)	$t_{1/2}$ (hr)	$V_d$ (mL/kg)	CL (mL/hr x kg)
Mean	8682.83	15117.50	1.05	588.83	341.00
SD	1413.71	2870.24	0.16	96.41	65.63
% CV	16.3	19.0	15.4	16.4	19.2
R-(-)-modafinil (5 mg/kg IV)					
Mean	7806.67	15905.17	1.53	646.67	340.33
SD	827.97	4958.47	1.11	68.10	102.39
% CV	10.6	31.2	72.5	10.5	30.1

These results suggest that there is no significant difference between the pharmacokinetics of R-(-)-modafinil and racemic modafinil following intravenous administration.

These results are in contrast to the pharmacokinetics of the isomers when administered by the oral route (See US Patent No. 4,927,855, which is herein incorporated by reference in its entirety). In said study, four dogs were administered 30 mg/kg oral dose of either R-(-)-modafinil (40-982), S-(+)-modafinil (40-983), or racemic modafinil (40-476). The AUC values were calculated from plasma concentration of both forms (40-476) and the sulfone metabolite measured from 2 to 9 hours post-dose administration. Table VIII shows the pharmacokinetic data.

Table VIII- PK parameters of racemic modafinil, R-(-)-modafinil, and S-(+)-modafinil from In Vivo study

Compound administered	Mean AUC (racemate)	Mean AUC (sulfone)
-----------------------	---------------------	--------------------

(30 mg/kg)	(mg/L x hr)	(mg/L x hr)
40-476 (racemate)	46.76 +/- 6.95	35.12 +/- 6.93
40-982 (R-(-)-modafinil)	97.22 +/- 12.58	8.69 +/- 1.22
40-983 (S-(+)-modafinil)	50.94 +/- 8.77	83.12 +/- 21.66

These results suggest striking differences in the metabolism of both isomers of modafinil, leading to differences in the formation of the inactive sulfone metabolite therefore resulting in higher exposure to the API when administered as R-(-)-modafinil. The different profile observed between the intravenous and the oral route could be explained by the fact that the formation of the sulfone metabolite is primarily catalyzed by cytochrome CYP3A4 which is both present at the intestinal and hepatic level, and that the affinity of CYP3A4 to S-(+)-modafinil is higher (stereoselective metabolism) than that to R-(-)-modafinil. This can result in faster metabolite formation with S-(+)-modafinil which can reduce the exposure to the API.

What is claimed is:

1. A pharmaceutical co-crystal composition, comprising: modafinil and a co-crystal former, wherein the co-crystal former is a solid at room temperature, and wherein the modafinil and the co-crystal former are hydrogen bonded to each other.
2. The pharmaceutical co-crystal composition according to claim 1, wherein:
  - (a) the co-crystal former is selected from a co-crystal former of Table I or Table II;
  - (b) the co-crystal former has at least one functional group selected from the group consisting of ether, thioether, alcohol, thiol, aldehyde, ketone, thioketone, nitrate ester, phosphate ester, thiophosphate ester, ester, thioester, sulfate ester, carboxylic acid, phosphonic acid, phosphinic acid, sulfonic acid, amide, primary amine, secondary amine, ammonia, tertiary amine, sp<sup>2</sup> amine, thiocyanate, cyanamide, oxime, nitrile diazo, organohalide, nitro, S-heterocyclic ring, thiophene, N-heterocyclic ring, pyrrole, O-heterocyclic ring, furan, epoxide, peroxide, hydroxamic acid, imidazole, and pyridine;
  - (c) the solubility of the co-crystal is increased as compared to the modafinil;
  - (d) the dose response of the co-crystal is increased as compared to the modafinil;
  - (e) the dissolution of the co-crystal is increased as compared to the modafinil;
  - (f) the bioavailability of the co-crystal is increased as compared to the modafinil; or
  - (g) the stability of the co-crystal is increased as compared to the modafinil.
3. A pharmaceutical co-crystal composition, comprising: modafinil, a co-crystal former, and a third molecule; wherein the co-crystal former is a solid at room temperature,



and wherein the modafinil and the third molecule are bonded to each other, and further wherein the co-crystal former and the third molecule are hydrogen bonded to each other.

4. The pharmaceutical co-crystal composition according to claim 3, wherein:
- (a) the co-crystal former is selected from a co-crystal former of Table I or Table II;
  - (b) the co-crystal former has at least one functional group selected from the group consisting of ether, thioether, alcohol, thiol, aldehyde, ketone, thioketone, nitrate ester, phosphate ester, thiophosphate ester, ester, thioester, sulfate ester, carboxylic acid, phosphonic acid, phosphinic acid, sulfonic acid, amide, primary amine, secondary amine, ammonia, tertiary amine, sp<sup>2</sup> amine, thiocyanate, cyanamide, oxime, nitrile diazo, organohalide, nitro, S-heterocyclic ring, thiophene, N-heterocyclic ring, pyrrole, O-heterocyclic ring, furan, epoxide, peroxide, hydroxamic acid, imidazole, and pyridine; or
  - (c) the solubility of the co-crystal is increased as compared to the modafinil;
  - (d) the dose response of the co-crystal is increased as compared to the modafinil;
  - (e) the dissolution of the co-crystal is increased as compared to the modafinil;
  - (f) the bioavailability of the co-crystal is increased as compared to the modafinil; or
  - (g) the stability of the co-crystal is increased as compared to the modafinil.
5. A pharmaceutical co-crystal composition, comprising: modafinil and a second API, wherein the second API is either a liquid or a solid at room temperature, and wherein the modafinil and the second API are hydrogen bonded to a molecule.

6. The pharmaceutical co-crystal composition according to claim 5, wherein:
- (a) the modafinil is hydrogen bonded to the second API;

- (b) the second API is a liquid at room temperature;
- (c) the second API is a solid at room temperature;
- (d) the second API has at least one functional group selected from the group consisting of ether, thioether, alcohol, thiol, aldehyde, ketone, thioketone, nitrate ester, phosphate ester, thiophosphate ester, ester, thioester, sulfate ester, carboxylic acid, phosphonic acid, phosphinic acid, sulfonic acid, amide, primary amine, secondary amine, ammonia, tertiary amine, sp<sup>2</sup> amine, thiocyanate, cyanamide, oxime, nitrile, diazo, organohalide, nitro, S-heterocyclic ring, thiophene, N-heterocyclic ring, pyrrole, O-heterocyclic ring, furan, epoxide, peroxide, hydroxamic acid, imidazole, and pyridine;
- (e) the solubility of the co-crystal is increased as compared to the modafinil;
- (f) the dose response of the co-crystal is increased as compared to the modafinil;
- (g) the dissolution of the co-crystal is increased as compared to the modafinil;
- (h) the bioavailability of the co-crystal is increased as compared to the modafinil; or
- (i) the stability of the co-crystal is increased as compared to the modafinil.

7. The pharmaceutical co-crystal composition according to claim 1, further comprising a pharmaceutically acceptable diluent, excipient, or carrier.

8. A co-crystal comprising modafinil and a co-crystal former selected from the group consisting of: malonic acid, glycolic acid, fumaric acid, tartaric acid, citric acid, succinic acid, gentisic acid, oxalic acid, 1-hydroxy-2-naphthoic acid, lauric acid, orotic acid, and maleic acid.

9. The co-crystal according to claim 8, wherein:

- (a) the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (i) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.11, 9.35, and 16.87 degrees;
- (ii) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises peaks at 16.87, 18.33, and 19.53 degrees;
- (iii) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.35, 19.53, and 22.89 degrees;
- (iv) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.11 and 9.35 degrees;
- (v) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises peaks at 16.87 and 19.53 degrees;
- (vi) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises peaks at 18.33 and 22.89 degrees;
- (vii) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises a peak at 5.11 degrees;
- (viii) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises a peak at 9.35 degrees; or
- (ix) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises a peak at 16.87 degrees;
- (b) the co-crystal is characterized by a DSC thermogram, wherein said co-crystal is a modafinil:malonic acid co-crystal and said DSC thermogram comprises an endothermic transition at about 106 degrees C; or
- (c) the co-crystal is characterized by a Raman spectrum comprising peaks expressed in terms of  $\text{cm}^{-1}$ , wherein:
  - (i) said co-crystal is a modafinil:malonic acid co-crystal and said Raman spectrum comprises peaks at 1004, 633, and 265;
  - (ii) said co-crystal is a modafinil:malonic acid co-crystal and said Raman spectrum comprises peaks at 1032, 1601, and 767;
  - (iii) said co-crystal is a modafinil:malonic acid co-crystal and said Raman spectrum comprises peaks at 1004 and 633;

- (iv) said co-crystal is a modafinil:malonic acid co-crystal and said Raman spectrum comprises peaks at 1183 and 767; or
- (v) said co-crystal is a modafinil:malonic acid co-crystal and said Raman spectrum comprises peaks at 1601 and 718.

10. The co-crystal according to claim 8, wherein the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said co-crystal is a modafinil:glycolic acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.51, 15.97, and 20.03 degrees;
- (b) said co-crystal is a modafinil:glycolic acid co-crystal and said X-ray diffraction pattern comprises peaks at 14.91, 19.01, and 22.75 degrees;
- (c) said co-crystal is a modafinil:glycolic acid co-crystal and said X-ray diffraction pattern comprises peaks at 15.97, 25.03, and 25.71 degrees;
- (d) said co-crystal is a modafinil:glycolic acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.51 and 15.97 degrees;
- (e) said co-crystal is a modafinil:glycolic acid co-crystal and said X-ray diffraction pattern comprises peaks at 20.03 and 25.03 degrees;
- (f) said co-crystal is a modafinil:glycolic acid co-crystal and said X-ray diffraction pattern comprises peaks at 15.97 and 25.03 degrees;
- (g) said co-crystal is a modafinil:glycolic acid co-crystal and said X-ray diffraction pattern comprises a peak at 9.51 degrees;
- (h) said co-crystal is a modafinil:glycolic acid co-crystal and said X-ray diffraction pattern comprises a peak at 15.97 degrees; or
- (i) said co-crystal is a modafinil:glycolic acid co-crystal and said X-ray diffraction pattern comprises a peak at 20.03 degrees.

11. The co-crystal according to claim 8, wherein:

- (a) the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (i) said co-crystal is a modafinil: maleic acid co-crystal and said X-ray diffraction pattern comprises peaks at 4.69, 6.15, and 9.61 degrees;
- (ii) said co-crystal is a modafinil: maleic acid co-crystal and said X-ray diffraction pattern comprises peaks at 10.23, 19.97, and 21.83 degrees;
- (iii) said co-crystal is a modafinil: maleic acid co-crystal and said X-ray diffraction pattern comprises peaks at 4.69, 10.23, and 21.83 degrees;
- (iv) said co-crystal is a modafinil: maleic acid co-crystal and said X-ray diffraction pattern comprises peaks at 4.69 and 19.97 degrees;
- (v) said co-crystal is a modafinil: maleic acid co-crystal and said X-ray diffraction pattern comprises peaks at 6.15 and 9.61 degrees;
- (vi) said co-crystal is a modafinil: maleic acid co-crystal and said X-ray diffraction pattern comprises peaks at 4.69 and 6.15 degrees;
- (vii) said co-crystal is a modafinil: maleic acid co-crystal and said X-ray diffraction pattern comprises a peak at 4.69 degrees;
- (viii) said co-crystal is a modafinil: maleic acid co-crystal and said X-ray diffraction pattern comprises a peak at 9.61 degrees; or
- (x) said co-crystal is a modafinil: maleic acid co-crystal and said X-ray diffraction pattern comprises a peak at 19.97 degrees; or
- (b) the co-crystal is characterized by a DSC thermogram, wherein said co-crystal is a modafinil: maleic acid co-crystal and said DSC thermogram comprises an endothermic transition at about 168 degrees C.

12. The co-crystal according to claim 8, wherein the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said co-crystal is a modafinil: L-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 6.10, 14.33, and 20.71 degrees;
- (b) said co-crystal is a modafinil: L-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 16.93, 20.15, and 22.49 degrees;

- (c) said co-crystal is a modafinil:L-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 16.93, 20.71, and 29.72 degrees;
- (d) said co-crystal is a modafinil:L-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 6.10 and 20.15 degrees;
- (e) said co-crystal is a modafinil:L-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 14.33 and 20.71 degrees;
- (f) said co-crystal is a modafinil:L-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 7.36 and 25.04 degrees;
- (g) said co-crystal is a modafinil:L-tartaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 6.10 degrees;
- (h) said co-crystal is a modafinil:L-tartaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 16.93 degrees; or
- (i) said co-crystal is a modafinil:L-tartaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 20.71 degrees.

13. The co-crystal according to claim 8, wherein the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.29, 7.29, and 9.31 degrees;
- (b) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises peaks at 12.41, 13.29, and 14.61 degrees;
- (c) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises peaks at 17.29, 17.97, and 21.37 degrees;
- (d) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.29 and 17.29 degrees;
- (e) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises peaks at 7.29 and 9.31 degrees;
- (f) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises peaks at 12.41 and 21.37 degrees;

- (g) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises a peak at 5.29 degrees;
- (h) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises a peak at 7.29 degrees; or
- (i) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises a peak at 12.41 degrees.

14. The co-crystal according to claim 8, wherein:

- (a) the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:
  - (i) said co-crystal is a modafinil: succinic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.45, 9.93, and 17.99 degrees;
  - (ii) said co-crystal is a modafinil: succinic acid co-crystal and said X-ray diffraction pattern comprises peaks at 19.95, 21.95, and 25.07 degrees;
  - (iii) said co-crystal is a modafinil: succinic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.45, 17.99, and 21.35 degrees;
  - (iv) said co-crystal is a modafinil: succinic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.45 and 9.93 degrees;
  - (v) said co-crystal is a modafinil: succinic acid co-crystal and said X-ray diffraction pattern comprises peaks at 17.99 and 21.95 degrees;
  - (vi) said co-crystal is a modafinil: succinic acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.93 and 19.95 degrees;
  - (vii) said co-crystal is a modafinil: succinic acid co-crystal and said X-ray diffraction pattern comprises a peak at 5.45 degrees;
  - (viii) said co-crystal is a modafinil: succinic acid co-crystal and said X-ray diffraction pattern comprises a peak at 9.93 degrees; or
  - (xi) said co-crystal is a modafinil: succinic acid co-crystal and said X-ray diffraction pattern comprises a peak at 17.99 degrees; or

- (b) the co-crystal is characterized by a DSC thermogram, wherein said co-crystal is a modafinil:succinic acid co-crystal and said DSC thermogram comprises an endothermic transition at about 149 degrees C.

15. The co-crystal according to claim 8, wherein the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 4.75, 9.53, and 15.83 degrees;
- (b) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 17.61, 20.25, and 22.55 degrees;
- (c) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 10.07, 17.61, and 21.53 degrees;
- (d) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 4.75 and 15.83 degrees;
- (e) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.53 and 17.61 degrees;
- (f) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 21.53 and 22.55 degrees;
- (g) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 4.75 degrees;
- (h) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 9.53 degrees; or
- (i) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 15.83 degrees.

16. The co-crystal according to claim 8, wherein the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:



- (a) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.45, 9.95, and 18.03 degrees;
- (b) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 15.93, 18.81, and 21.95 degrees;
- (c) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.95, 19.93, and 23.09 degrees;
- (d) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.45 and 9.95 degrees;
- (e) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.45 and 18.03 degrees;
- (f) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 15.93 and 21.95 degrees;
- (g) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 5.45 degrees;
- (h) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 9.95 degrees; or
- (i) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 18.03 degrees.

17. The co-crystal according to claim 16, wherein the co-crystal is modafinil:fumaric acid Form I.

18. The co-crystal according to claim 8, wherein the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 6.47, 8.57, and 9.99 degrees;
- (b) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 13.89, 14.53, and 20.79 degrees;

- (c) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 16.45, 18.39, and 20.05 degrees;
- (d) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 6.47 and 20.79 degrees;
- (e) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.99 and 14.53 degrees;
- (f) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 13.89 and 20.05 degrees;
- (g) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 6.47 degrees;
- (h) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 13.89 degrees; or
- (i) said co-crystal is a modafinil:fumaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 20.79 degrees.

19. The co-crystal according to claim 18, wherein the co-crystal is modafinil:fumaric acid Form II.

20. The co-crystal according to claim 8, wherein the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said co-crystal is a modafinil:gentisic acid co-crystal and said X-ray diffraction pattern comprises peaks at 6.96, 12.92, and 14.76 degrees;
- (b) said co-crystal is a modafinil:gentisic acid co-crystal and said X-ray diffraction pattern comprises peaks at 14.76, 18.26, and 20.10 degrees;
- (c) said co-crystal is a modafinil:gentisic acid co-crystal and said X-ray diffraction pattern comprises peaks at 6.96, 17.40, and 20.94 degrees;
- (d) said co-crystal is a modafinil:gentisic acid co-crystal and said X-ray diffraction pattern comprises peaks at 6.96 and 14.76 degrees;

- (e) said co-crystal is a modafinil:gentisic acid co-crystal and said X-ray diffraction pattern comprises peaks at 12.92 and 17.40 degrees;
- (f) said co-crystal is a modafinil:gentisic acid co-crystal and said X-ray diffraction pattern comprises peaks at 6.96 and 18.26 degrees;
- (g) said co-crystal is a modafinil:gentisic acid co-crystal and said X-ray diffraction pattern comprises a peak at 6.96 degrees;
- (h) said co-crystal is a modafinil:gentisic acid co-crystal and said X-ray diffraction pattern comprises a peak at 14.76 degrees; or
- (i) said co-crystal is a modafinil:gentisic acid co-crystal and said X-ray diffraction pattern comprises a peak at 18.26 degrees.

21. The co-crystal according to claim 8, wherein the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said co-crystal is a modafinil:oxalic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.98, 17.54, and 19.68 degrees;
- (b) said co-crystal is a modafinil:oxalic acid co-crystal and said X-ray diffraction pattern comprises peaks at 13.68, 14.80, and 21.12 degrees;
- (c) said co-crystal is a modafinil:oxalic acid co-crystal and said X-ray diffraction pattern comprises peaks at 17.54, 19.68, and 21.86 degrees;
- (d) said co-crystal is a modafinil:oxalic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.98 and 19.68 degrees;
- (e) said co-crystal is a modafinil:oxalic acid co-crystal and said X-ray diffraction pattern comprises peaks at 13.68 and 14.80 degrees;
- (f) said co-crystal is a modafinil:oxalic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.98 and 17.54 degrees;
- (g) said co-crystal is a modafinil:oxalic acid co-crystal and said X-ray diffraction pattern comprises a peak at 5.98 degrees;
- (h) said co-crystal is a modafinil:oxalic acid co-crystal and said X-ray diffraction pattern comprises a peak at 19.68 degrees; or

- (i) said co-crystal is a modafinil:oxalic acid co-crystal and said X-ray diffraction pattern comprises a peak at 17.54 degrees.

22. The co-crystal according to claim 8, wherein the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.72, 7.10, and 14.16 degrees;
- (b) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises peaks at 11.48, 15.66, and 20.26 degrees;
- (c) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.72, 7.10, and 20.26 degrees;
- (d) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.72 and 7.10 degrees;
- (e) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises peaks at 14.16 and 20.26 degrees;
- (f) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.72 and 14.16 degrees;
- (g) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises a peak at 5.72 degrees;
- (h) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises a peak at 7.10 degrees; or
- (i) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises a peak at 14.16 degrees.

23. The co-crystal according to claim 8, wherein:

- (a) the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (i) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.04, 9.26, and 16.73 degrees;
- (ii) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises peaks at 18.23, 19.37, and 22.74 degrees;
- (iii) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.04, 16.73, and 19.37 degrees;
- (iv) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.04 and 9.26 degrees;
- (v) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises peaks at 16.73 and 19.37 degrees;
- (vi) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.26 and 18.23 degrees;
- (vii) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises a peak at 5.04 degrees;
- (viii) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises a peak at 9.26 degrees; or
- (ix) said co-crystal is a modafinil:malonic acid co-crystal and said X-ray diffraction pattern comprises a peak at 19.37 degrees; or
- (b) the co-crystal is characterized by a DSC thermogram, wherein said co-crystal is a modafinil:malonic acid co-crystal and said DSC thermogram comprises an endothermic transition at about 115 degrees C.

24. The co-crystal according to claim 23, wherein the modafinil is R-(-)-modafinil.

25. The co-crystal according to claim 8, wherein:

- (a) the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:
  - (i) said co-crystal is a modafinil:succinic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.36, 9.83, and 17.88 degrees;

- (ii) said co-crystal is a modafinil:succinic acid co-crystal and said X-ray diffraction pattern comprises peaks at 15.80, 19.87, and 21.85 degrees;
- (iii) said co-crystal is a modafinil:succinic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.36, 9.83, and 21.85 degrees;
- (iv) said co-crystal is a modafinil:succinic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.36 and 9.83 degrees;
- (v) said co-crystal is a modafinil:succinic acid co-crystal and said X-ray diffraction pattern comprises peaks at 17.88 and 19.87 degrees;
- (vi) said co-crystal is a modafinil:succinic acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.83 and 15.80 degrees;
- (vii) said co-crystal is a modafinil:succinic acid co-crystal and said X-ray diffraction pattern comprises a peak at 5.36 degrees;
- (viii) said co-crystal is a modafinil:succinic acid co-crystal and said X-ray diffraction pattern comprises a peak at 9.83 degrees; or
- (ix) said co-crystal is a modafinil:succinic acid co-crystal and said X-ray diffraction pattern comprises a peak at 17.88 degrees; or
- (b) the co-crystal is characterized by a DSC thermogram, wherein said co-crystal is a modafinil:succinic acid co-crystal and said DSC thermogram comprises an endothermic transition at about 145 degrees C.

26. The co-crystal according to claim 25, wherein the modafinil is R-(-)-modafinil.

27. The co-crystal according to claim 8, wherein:

- (a) the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:
  - (i) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.18, 7.23, and 9.23 degrees;

- (ii) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises peaks at 12.32, 13.23, and 17.25 degrees;
- (iii) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.23, 17.92, and 21.30 degrees;
- (iv) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.18 and 9.23 degrees;
- (v) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises peaks at 7.23 and 13.23 degrees;
- (vi) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises peaks at 17.25 and 17.92 degrees;
- (vii) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises a peak at 5.18 degrees;
- (viii) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises a peak at 7.23 degrees; or
- (ix) said co-crystal is a modafinil: citric acid co-crystal and said X-ray diffraction pattern comprises a peak at 9.23 degrees; or
- (b) the co-crystal is characterized by a DSC thermogram, wherein said co-crystal is a modafinil: citric acid co-crystal and said DSC thermogram comprises an endothermic transition at about 89 degrees C.

28. The co-crystal according to claim 27, wherein the modafinil is R-(-)-modafinil.

29. The co-crystal according to claim 8, wherein the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said co-crystal is a modafinil: 1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.77, 7.11, and 9.09 degrees;

- (b) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises peaks at 10.37, 12.23, and 14.81 degrees;
- (c) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises peaks at 14.17, 17.09, and 21.39 degrees;
- (d) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.09 and 14.81 degrees;
- (e) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises peaks at 5.77 and 10.37 degrees;
- (f) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises peaks at 7.11 and 14.17 degrees;
- (g) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises a peak at 5.77 degrees;
- (h) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises a peak at 9.09 degrees; or
- (i) said co-crystal is a modafinil:1-hydroxy-2-naphthoic acid co-crystal and said X-ray diffraction pattern comprises a peak at 14.81 degrees.

30. The co-crystal according to claim 29, wherein the modafinil is R-(-)-modafinil.

31. The co-crystal according to claim 8, wherein the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 4.67, 15.41, and 19.46 degrees;
- (b) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 17.97, 19.46, and 22.91 degrees;
- (c) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 4.67, 22.91, and 24.63 degrees;



- (d) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 4.67 and 19.46 degrees;
- (e) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 17.97 and 22.91 degrees;
- (f) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises peaks at 15.41 and 24.63 degrees;
- (g) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 4.67 degrees;
- (h) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 19.46 degrees; or
- (i) said co-crystal is a modafinil:DL-tartaric acid co-crystal and said X-ray diffraction pattern comprises a peak at 22.91 degrees.

32. The co-crystal according to claim 31, wherein the modafinil is R-(-)-modafinil.

33. The co-crystal according to claim 8, wherein the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said co-crystal is a modafinil:lauric acid co-crystal and said X-ray diffraction pattern comprises peaks at 3.15, 7.17, and 10.25 degrees;
- (b) said co-crystal is a modafinil:lauric acid co-crystal and said X-ray diffraction pattern comprises peaks at 17.67, 21.43, and 23.84 degrees;
- (c) said co-crystal is a modafinil:lauric acid co-crystal and said X-ray diffraction pattern comprises peaks at 3.15, 10.25, and 21.43 degrees;
- (d) said co-crystal is a modafinil:lauric acid co-crystal and said X-ray diffraction pattern comprises peaks at 3.15 and 10.25 degrees;
- (e) said co-crystal is a modafinil:lauric acid co-crystal and said X-ray diffraction pattern comprises peaks at 17.67 and 21.43 degrees;
- (f) said co-crystal is a modafinil:lauric acid co-crystal and said X-ray diffraction pattern comprises peaks at 7.17 and 23.84 degrees;

- (g) said co-crystal is a modafinil:lauric acid co-crystal and said X-ray diffraction pattern comprises a peak at 3.15 degrees;
- (h) said co-crystal is a modafinil:lauric acid co-crystal and said X-ray diffraction pattern comprises a peak at 10.25 degrees; or
- (i) said co-crystal is a modafinil:lauric acid co-crystal and said X-ray diffraction pattern comprises a peak at 21.43 degrees.

34. The co-crystal according to claim 33, wherein the modafinil is R-(-)-modafinil.

35. The co-crystal according to claim 8, wherein the co-crystal is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said co-crystal is a modafinil:orotic acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.77, 17.85, and 20.52 degrees;
- (b) said co-crystal is a modafinil:orotic acid co-crystal and said X-ray diffraction pattern comprises peaks at 14.61, 24.03, and 26.80 degrees;
- (c) said co-crystal is a modafinil:orotic acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.77, 20.52, and 24.03 degrees;
- (d) said co-crystal is a modafinil:orotic acid co-crystal and said X-ray diffraction pattern comprises peaks at 9.77 and 14.61 degrees;
- (e) said co-crystal is a modafinil:orotic acid co-crystal and said X-ray diffraction pattern comprises peaks at 17.85 and 24.03 degrees;
- (f) said co-crystal is a modafinil:orotic acid co-crystal and said X-ray diffraction pattern comprises peaks at 14.61 and 26.80 degrees;
- (g) said co-crystal is a modafinil:orotic acid co-crystal and said X-ray diffraction pattern comprises a peak at 9.77 degrees;
- (h) said co-crystal is a modafinil:orotic acid co-crystal and said X-ray diffraction pattern comprises a peak at 17.85 degrees; or
- (i) said co-crystal is a modafinil:orotic acid co-crystal and said X-ray diffraction pattern comprises a peak at 24.03 degrees.

36. The co-crystal according to claim 35, wherein the modafinil is R-(-)-modafinil.
37. A pharmaceutical composition wherein the composition is a solvate form and is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:
- (a) said form is a modafinil acetic acid solvate and said X-ray diffraction pattern comprises peaks at 6.17, 9.63, and 19.99 degrees;
  - (b) said form is a modafinil acetic acid solvate and said X-ray diffraction pattern comprises peaks at 6.17 and 9.63 degrees;
  - (c) said form is a modafinil acetic acid solvate and said X-ray diffraction pattern comprises peaks at 19.99 and 21.83 degrees;
  - (d) said form is a modafinil acetic acid solvate and said X-ray diffraction pattern comprises peaks at 9.63 and 19.99 degrees; or
  - (e) said form is a modafinil acetic acid solvate and said X-ray diffraction pattern comprises a peak at 6.17 degrees.
38. A pharmaceutical composition wherein the composition is a solvate form and is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:
- (a) said form is a modafinil tetrahydrofuran solvate and said X-ray diffraction pattern comprises peaks at 6.97, 9.79, and 10.97 degrees;
  - (b) said form is a modafinil tetrahydrofuran solvate and said X-ray diffraction pattern comprises peaks at 10.97 and 20.59 degrees;
  - (c) said form is a modafinil tetrahydrofuran solvate and said X-ray diffraction pattern comprises peaks at 9.79 and 19.03 degrees;
  - (d) said form is a modafinil tetrahydrofuran solvate and said X-ray diffraction pattern comprises peaks at 6.97 and 16.19 degrees; or
  - (e) said form is a modafinil tetrahydrofuran solvate and said X-ray diffraction pattern comprises a peak at 6.97 degrees.

39. A pharmaceutical composition wherein the composition is a solvate form and is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said form is a modafinil 1,4-dioxane solvate and said X-ray diffraction pattern comprises peaks at 6.93, 9.85, and 10.97 degrees;
- (b) said form is a modafinil 1,4-dioxane solvate and said X-ray diffraction pattern comprises peaks at 6.93 and 20.65 degrees;
- (c) said form is a modafinil 1,4-dioxane solvate and said X-ray diffraction pattern comprises peaks at 10.97 and 18.97 degrees;
- (d) said form is a modafinil 1,4-dioxane solvate and said X-ray diffraction pattern comprises peaks at 16.19 and 23.33 degrees; or
- (e) said form is a modafinil 1,4-dioxane solvate and said X-ray diffraction pattern comprises a peak at 6.93 degrees.

40. A pharmaceutical composition wherein the composition is a solvate form and is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said form is a modafinil methanol solvate and said X-ray diffraction pattern comprises peaks at 6.15, 9.89, and 20.07 degrees;
- (b) said form is a modafinil methanol solvate and said X-ray diffraction pattern comprises peaks at 6.15 and 9.89 degrees;
- (c) said form is a modafinil methanol solvate and said X-ray diffraction pattern comprises peaks at 12.25 and 17.97 degrees;
- (d) said form is a modafinil methanol solvate and said X-ray diffraction pattern comprises peaks at 20.07 and 21.85 degrees; or
- (e) said form is a modafinil methanol solvate and said X-ray diffraction pattern comprises a peak at 6.15 degrees.

41. A pharmaceutical composition wherein the composition is a solvate form and is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said form is a modafinil nitromethane solvate and said X-ray diffraction pattern comprises peaks at 6.17, 9.77, and 20.07 degrees;
- (b) said form is a modafinil nitromethane solvate and said X-ray diffraction pattern comprises peaks at 12.29 and 15.89 degrees;
- (c) said form is a modafinil nitromethane solvate and said X-ray diffraction pattern comprises peaks at 6.17 and 20.07 degrees;
- (d) said form is a modafinil nitromethane solvate and said X-ray diffraction pattern comprises peaks at 9.77 and 22.17 degrees; or
- (e) said form is a modafinil nitromethane solvate and said X-ray diffraction pattern comprises a peak at 6.17 degrees.

42. A pharmaceutical composition wherein the composition is a solvate form and is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said form is a modafinil acetone solvate and said X-ray diffraction pattern comprises peaks at 6.11, 9.53, and 15.81 degrees;
- (b) said form is a modafinil acetone solvate and said X-ray diffraction pattern comprises peaks at 6.11 and 9.53 degrees;
- (c) said form is a modafinil acetone solvate and said X-ray diffraction pattern comprises peaks at 15.81 and 20.03 degrees;
- (d) said form is a modafinil acetone solvate and said X-ray diffraction pattern comprises peaks at 18.11 and 21.63 degrees; or
- (e) said form is a modafinil acetone solvate and said X-ray diffraction pattern comprises a peak at 6.11 degrees.

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43. A pharmaceutical composition wherein:

- (a) the composition is a polymorph and is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:
  - (i) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 8.97, 10.15, and 20.39 degrees;
  - (ii) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 8.97 and 18.19 degrees;
  - (iii) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 10.15 and 20.39 degrees;
  - (iv) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 15.77 and 19.25 degrees; or
  - (v) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises a peak at 8.97 degrees; or
- (b) the composition is characterized by a DSC thermogram, wherein said composition is a modafinil polymorph and said DSC thermogram comprises an endothermic transition at about 167 degrees C.

44. The pharmaceutical composition of claim 43, wherein the modafinil is R-(-)-modafinil.

45. The pharmaceutical composition of claim 44, wherein the composition is a mixture of R-(-)-modafinil Forms I and II.

46. A pharmaceutical composition wherein:

- (a) the composition is a polymorph and is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:
  - (i) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 7.21, 10.37, and 17.73 degrees;

- (ii) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 7.21 and 10.37 degrees;
- (iii) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 17.73 and 19.23 degrees;
- (iv) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 10.37 and 21.77 degrees; or
- (v) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises a peak at 7.21 degrees; or
- (b) the composition is characterized by a DSC thermogram, wherein said composition is a modafinil polymorph and said DSC thermogram comprises an endothermic transition at about 161 degrees C.

47. The pharmaceutical composition of claim 43, wherein the modafinil is R-(-)-modafinil.

48. The pharmaceutical composition of claim 44, wherein the composition is R-(-)-modafinil Form III.

49. A pharmaceutical composition wherein the composition is a polymorph and is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:

- (a) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 6.61, 10.39, and 16.49 degrees;
- (b) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 6.61 and 10.39 degrees;
- (c) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 13.99 and 17.73 degrees; or
- (d) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 20.87 and 22.31 degrees; or

- (e) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises a peak at 6.61 degrees.

50. The pharmaceutical composition of claim 43, wherein the modafinil is R-(-)-modafinil.

51. The pharmaceutical composition of claim 44, wherein the composition is R-(-)-modafinil Form V.

52. A pharmaceutical composition wherein:

- (a) the composition is a polymorph and is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:
  - (i) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 7.79, 10.31, and 11.77 degrees;
  - (ii) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 7.79 and 10.31 degrees;
  - (iii) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 16.49 and 17.33 degrees;
  - (iv) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises peaks at 19.47 and 23.51 degrees; or
  - (v) said composition is a modafinil polymorph and said X-ray diffraction pattern comprises a peak at 7.79 degrees; or
- (b) the composition is characterized by a DSC thermogram, wherein said composition is a modafinil polymorph and said DSC thermogram comprises an endothermic transition at about 147 degrees C.

53. The pharmaceutical composition of claim 43, wherein the modafinil is R-(-)-modafinil.



54. The pharmaceutical composition of claim 44, wherein the composition is R-(-)-modafinil Form IV.
55. The co-crystal of claim 1, wherein the co-crystal former is a carboxylic acid.
56. The co-crystal of claim 55, wherein a carboxylic acid functional group of the co-crystal former interacts with the primary amide or the S=O of modafinil by hydrogen bonding.
57. The co-crystal of claim 55, wherein a carboxylic acid functional group of the co-crystal former interacts with the periphery of the amide dimer of modafinil by hydrogen bonding.
58. The co-crystal of claim 55, wherein a carboxylic acid functional group of the co-crystal former interacts with the amide dimer and the S=O of modafinil by hydrogen bonding.
59. The co-crystal of claim 55, wherein a carboxylic acid functional group of the co-crystal former interacts with two amide dimers of modafinil by hydrogen bonding.
60. The co-crystal of claim 1, wherein the modafinil is R-(-)-modafinil.
61. The co-crystal of claim 1, wherein the modafinil is S-(+)-modafinil.
62. The co-crystal of claim 8, wherein the modafinil is R-(-)-modafinil.
63. The co-crystal of claim 8, wherein the modafinil is S-(+)-modafinil.
64. A process for preparing a pharmaceutical co-crystal composition comprising modafinil and a co-crystal former, comprising:

- (a) providing modafinil and a co-crystal former, wherein the co-crystal former is a solid at room temperature;
  - (b) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase, wherein the modafinil and co-crystal former are hydrogen bonded to each other;
  - (c) isolating co-crystals formed thereby; and
  - (d) incorporating the co-crystals into a pharmaceutical composition.
65. The process of claim 64, wherein:
- (a) the co-crystal former is selected from a co-crystal former of Table I or Table II; or
  - (b) the co-crystal former has at least one functional group selected from the group consisting of ether, thioether, alcohol, thiol, aldehyde, ketone, thioketone, nitrate ester, phosphate ester, thiophosphate ester, ester, thioester, sulfate ester, carboxylic acid, phosphonic acid, phosphinic acid, sulfonic acid, amide, primary amine, secondary amine, ammonia, tertiary amine, sp<sup>2</sup> amine, thiocyanate, cyanamide, oxime, nitrile diazo, organohalide, nitro, S-heterocyclic ring, thiophene, N-heterocyclic ring, pyrrole, O-heterocyclic ring, furan, epoxide, peroxide, hydroxamic acid, imidazole, and pyridine.
66. A process for preparing a pharmaceutical co-crystal composition comprising modafinil, a co-crystal former, and a third molecule, comprising:
- (a) providing modafinil and a co-crystal former, wherein the co-crystal former is a solid at room temperature;
  - (b) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase, wherein the modafinil and the third molecule

- are bonded to each other, and further wherein the co-crystal former and the third molecule are hydrogen bonded to each other;
- (c) isolating co-crystals formed thereby; and
- (d) incorporating the co-crystals into a pharmaceutical composition.

67. The process of claim 66, wherein:

- (a) the co-crystal former is selected from a co-crystal former of Table I or Table II; or
- (b) the co-crystal former has at least one functional group selected from the group consisting of ether, thioether, alcohol, thiol, aldehyde, ketone, thioketone, nitrate ester, phosphate ester, thiophosphate ester, ester, thioester, sulfate ester, carboxylic acid, phosphonic acid, phosphinic acid, sulfonic acid, amide, primary amine, secondary amine, ammonia, tertiary amine, sp<sup>2</sup> amine, thiocyanate, cyanamide, oxime, nitrile diazo, organohalide, nitro, S-heterocyclic ring, thiophene, N-heterocyclic ring, pyrrole, O-heterocyclic ring, furan, epoxide, peroxide, hydroxamic acid, imidazole, and pyridine.

68. A process for preparing a pharmaceutical co-crystal composition comprising modafinil and a second API, comprising:

- (a) providing modafinil and a second API, wherein the second API is either a liquid or a solid at room temperature;
- (b) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil and the second API under crystallization conditions, so as to form a solid phase, wherein the modafinil and the second API are hydrogen bonded to a molecule;
- (c) isolating co-crystals formed thereby; and
- (d) incorporating the co-crystals into a pharmaceutical composition.

69. The process of claim 68, wherein:

- (a) modafinil is hydrogen bonded to the second API;
- (b) the second API is a liquid at room temperature;
- (c) the second API is a solid at room temperature; or
- (d) the second API has at least one functional group selected from the group consisting of ether, thioether, alcohol, thiol, aldehyde, ketone, thioketone, nitrate ester, phosphate ester, thiophosphate ester, ester, thioester, sulfate ester, carboxylic acid, phosphonic acid, phosphinic acid, sulfonic acid, amide, primary amine, secondary amine, ammonia, tertiary amine, sp<sup>2</sup> amine, thiocyanate, cyanamide, oxime, nitrile, diazo, organohalide, nitro, S-heterocyclic ring, thiophene, N-heterocyclic ring, pyrrole, O-heterocyclic ring, furan, epoxide, peroxide, hydroxamic acid, imidazole, and pyridine.

70. The process of claim 64, further comprising: incorporating a pharmaceutically acceptable diluent, excipient, or carrier.

71. A process of preparing a co-crystal comprising modafinil and a co-crystal former, comprising:

- (a) providing modafinil and a co-crystal former;
- (b) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with the co-crystal former under crystallization conditions, so as to form a solid phase; and
- (c) isolating co-crystals formed thereby;  
wherein the co-crystal former is selected from the group consisting of malonic acid, benzamide, mandelic acid, glycolic acid, fumaric acid, and maleic acid.

72. A process for modulating the solubility of modafinil for use in a pharmaceutical composition, which process comprises:

- (a) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with a co-crystal forming compound under crystallization conditions, so as to form a co-crystal of the modafinil and the co-crystal forming compound;
- (b) isolating the co-crystal, wherein the co-crystal has a modulated solubility as compared to the modafinil; and
- (c) incorporating the co-crystal having modulated solubility into a pharmaceutical composition.

73. The process of claim 72, wherein the solubility of the co-crystal is increased as compared to the modafinil.

74. A process for modulating the dose response of modafinil for use in a pharmaceutical composition, which process comprises:

- (a) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with a co-crystal forming compound under crystallization conditions, so as to form a co-crystal of the modafinil and the co-crystal forming compound;
- (b) isolating the co-crystal, wherein the co-crystal has a modulated dose response as compared to the modafinil; and
- (c) incorporating the co-crystal having modulated dose response into a pharmaceutical composition.

75. The process of claim 74, wherein the dose response of the co-crystal is increased as compared to the modafinil.

76. A process for modulating the dissolution of modafinil for use in a pharmaceutical composition, which process comprises:

- (a) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with a co-crystal forming compound under crystallization

conditions, so as to form a co-crystal of the modafinil and the co-crystal forming compound;

- (b) isolating the co-crystal, wherein the co-crystal has a modulated dissolution as compared to the modafinil; and
- (c) incorporating the co-crystal having modulated dissolution into a pharmaceutical composition.

77. The process of claim 76, wherein the dissolution of the co-crystal is increased as compared to the modafinil.

78. A process for modulating the bioavailability of modafinil for use in a pharmaceutical composition, which process comprises:

- (a) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with a co-crystal forming compound under crystallization conditions, so as to form a co-crystal of the modafinil and the co-crystal forming compound;
- (b) isolating the co-crystal, wherein the co-crystal has a modulated bioavailability as compared to the modafinil; and
- (c) incorporating the co-crystal having modulated bioavailability into a pharmaceutical composition.

79. The process of claim 78, wherein the bioavailability of the co-crystal is increased as compared to the modafinil.

80. A process for increasing the stability of modafinil for use in a pharmaceutical composition, which process comprises:

- (a) grinding, heating, co-subliming, co-melting, or contacting in solution the modafinil with a co-crystal forming compound under crystallization conditions, so as to form a co-crystal of the modafinil and the co-crystal forming compound;

- (b) isolating the co-crystal, wherein the co-crystal has increased stability as compared to the modafinil; and
- (c) incorporating the co-crystal having increased stability into a pharmaceutical composition.

81. A process for modulating the morphology of modafinil for use in a pharmaceutical composition, which process comprises:

- (a) grinding, heating, co-subliming, co-melting, or contacting in solution modafinil with a co-crystal forming compound under crystallization conditions, so as to form a co-crystal of the modafinil and the co-crystal forming compound;
- (b) isolating the co-crystal, wherein the co-crystal has a different morphology as compared to the modafinil; and
- (c) incorporating the co-crystal having modulated morphology into a pharmaceutical composition.

82. A method of making a polymorph of R-(-)-modafinil, comprising:

- (a) providing R-(-)-modafinil; and
- (b) crystallizing the polymorph of R-(-)-modafinil from an appropriate solvent.

83. A method of making R-(-)-modafinil form I and form II, comprising:

- (a) providing R-(-)-modafinil; and
- (b) crystallizing the R-(-)-modafinil form I and form II from ethanol.

84. A method of making R-(-)-modafinil form III, comprising:

- (a) providing R-(-)-modafinil; and
- (b) crystallizing the R-(-)-modafinil form III from ethanol and isopropyl alcohol.

---

85. A method of making R-(-)-modafinil form IV, comprising:

- (a) providing R-(-)-modafinil; and

- (b) crystallizing the R-(-)-modafinil form IV from ethyl acetate and ethanol.
86. A method of making R-(-)-modafinil form V, comprising:
- (a) providing R-(-)-modafinil; and
  - (b) crystallizing the R-(-)-modafinil form V from ethyl acetate and ethanol.
87. A pharmaceutical composition comprising a co-crystal of modafinil.
88. The pharmaceutical composition according to claim 87, further comprising a pharmaceutically acceptable diluent, excipient, or carrier.
89. A method for treating a subject suffering from excessive daytime sleepiness associated with narcolepsy, multiple sclerosis related fatigue, infertility, eating disorders, attention deficit hyperactivity disorder (ADHD), Parkinson's disease, incontinence, sleep apnea, or myopathies, which comprises administering to a subject a therapeutically effective amount of a co-crystal comprising modafinil.
90. The method according to claim 89, wherein the subject is a human subject.
91. A pharmaceutical composition wherein:
- (a) the composition is an R-(-)-modafinil polymorph and is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:
    - (i) said composition is an R-(-)-modafinil polymorph and said X-ray diffraction pattern comprises peaks at 8.97, 10.15, and 15.77 degrees;
    - (ii) said composition is an R-(-)-modafinil polymorph and said X-ray diffraction pattern comprises peaks at 8.97 and 19.25 degrees;
    - (iii) said composition is an R-(-)-modafinil polymorph and said X-ray diffraction pattern comprises peaks at 10.15 and 15.77 degrees;



- (iv) said composition is an R-(-)-modafinil polymorph and said X-ray diffraction pattern comprises peaks at 18.19 and 19.25 degrees; or
- (vi) said composition is an R-(-)-modafinil polymorph and said X-ray diffraction pattern comprises a peak at 8.97 degrees; or
- (b) the composition is characterized by a DSC thermogram, wherein said composition is an R-(-)-modafinil polymorph and said DSC thermogram comprises an endothermic transition at about 167 degrees C.

92. A pharmaceutical composition wherein:

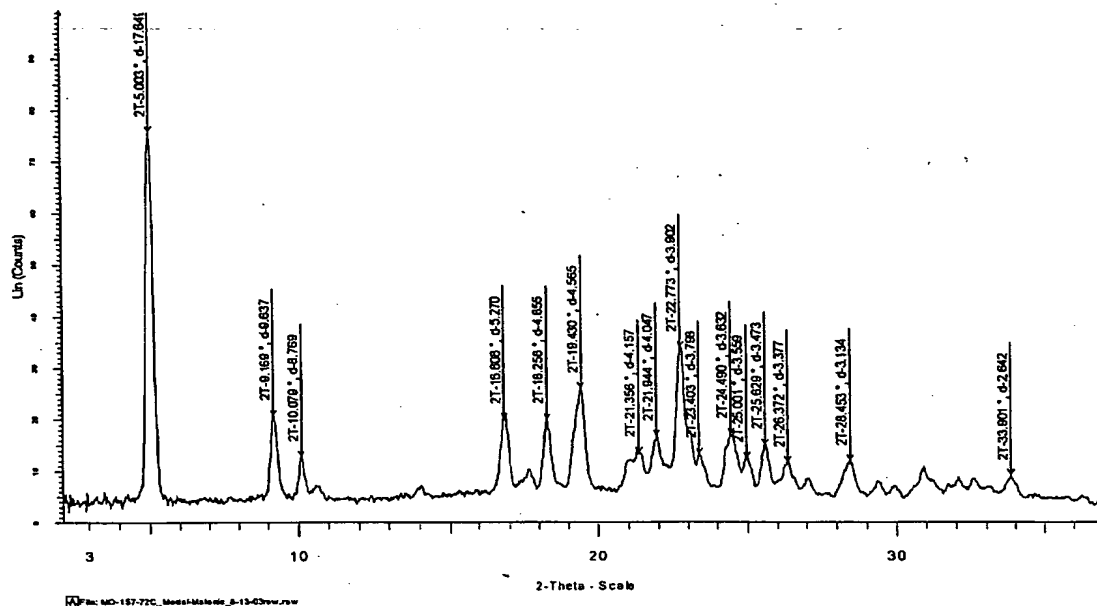
- (a) the composition is an R-(-)-modafinil polymorph and is characterized by a powder X-ray diffraction pattern comprising peaks expressed in terms of 2-theta angles, wherein:
  - (i) said composition is an R-(-)-modafinil polymorph and said X-ray diffraction pattern comprises peaks at 14.15, 17.41, and 18.19 degrees;
  - (ii) said composition is an R-(-)-modafinil polymorph and said X-ray diffraction pattern comprises peaks at 8.97 and 14.15 degrees;
  - (iii) said composition is an R-(-)-modafinil polymorph and said X-ray diffraction pattern comprises peaks at 10.15 and 17.41 degrees;
  - (iv) said composition is an R-(-)-modafinil polymorph and said X-ray diffraction pattern comprises peaks at 14.15 and 17.41 degrees; or
  - (vii) said composition is an R-(-)-modafinil polymorph and said X-ray diffraction pattern comprises a peak at 14.15 degrees; or
- (b) the composition is characterized by a DSC thermogram, wherein said composition is an R-(-)-modafinil polymorph and said DSC thermogram comprises an endothermic transition at about 167 degrees C.

93. The pharmaceutical composition of claim 44, wherein the composition is R-(-)-modafinil Form I.

94. The pharmaceutical composition of claim 44, wherein the composition is R-(-)-modafinil Form II.

### **Abstract**

**Co-crystals and solvates of modafinil are formed and several important physical properties are modulated. The solubility, dissolution, bioavailability, dose response, and stability of modafinil can be modulated to improve efficacy in pharmaceutical compositions.**



Angle  
2-Theta  
Degrees

5.003  
9.169  
10.079  
16.808  
18.258  
19.43  
21.356  
21.944  
22.773  
23.403  
24.49  
25.001  
25.629  
26.372  
28.453  
33.901

Figure 1

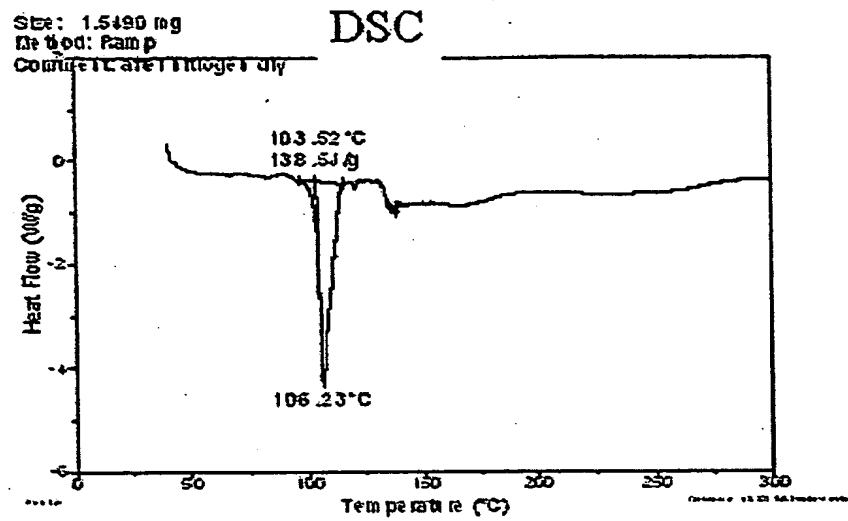


Figure 2

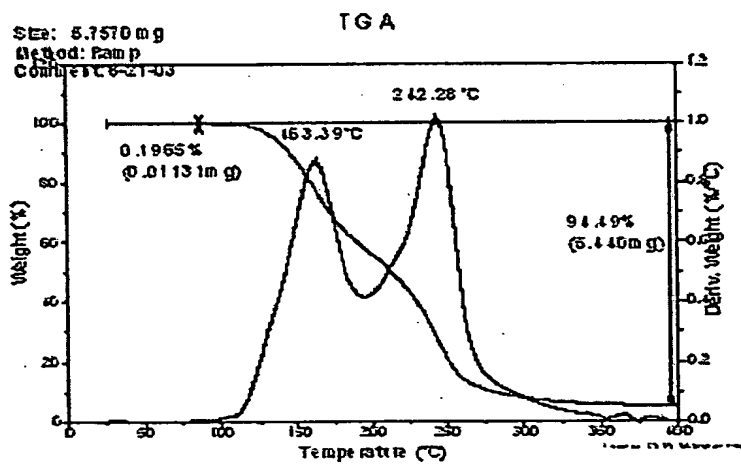


Figure 3

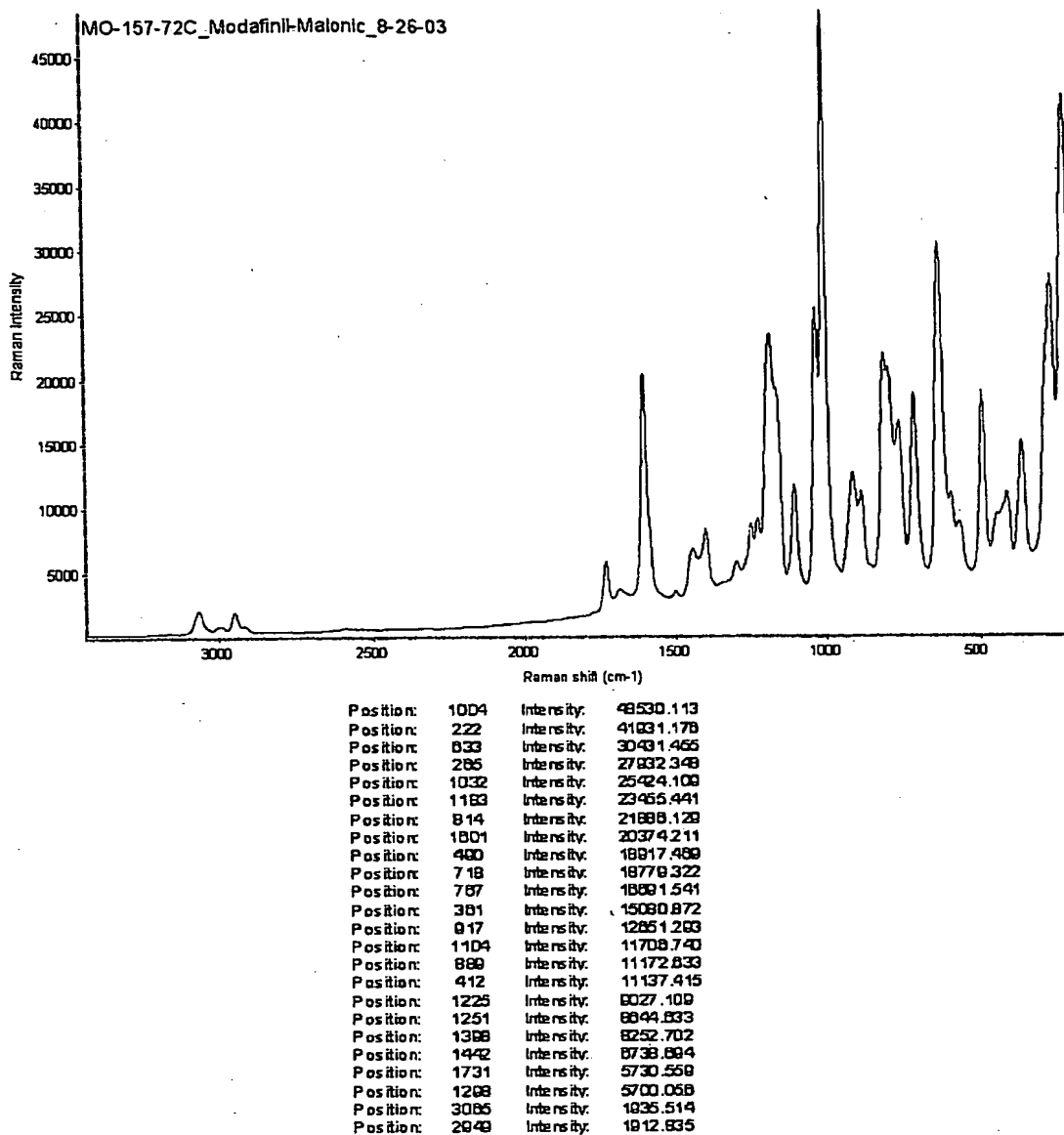


Figure 4A

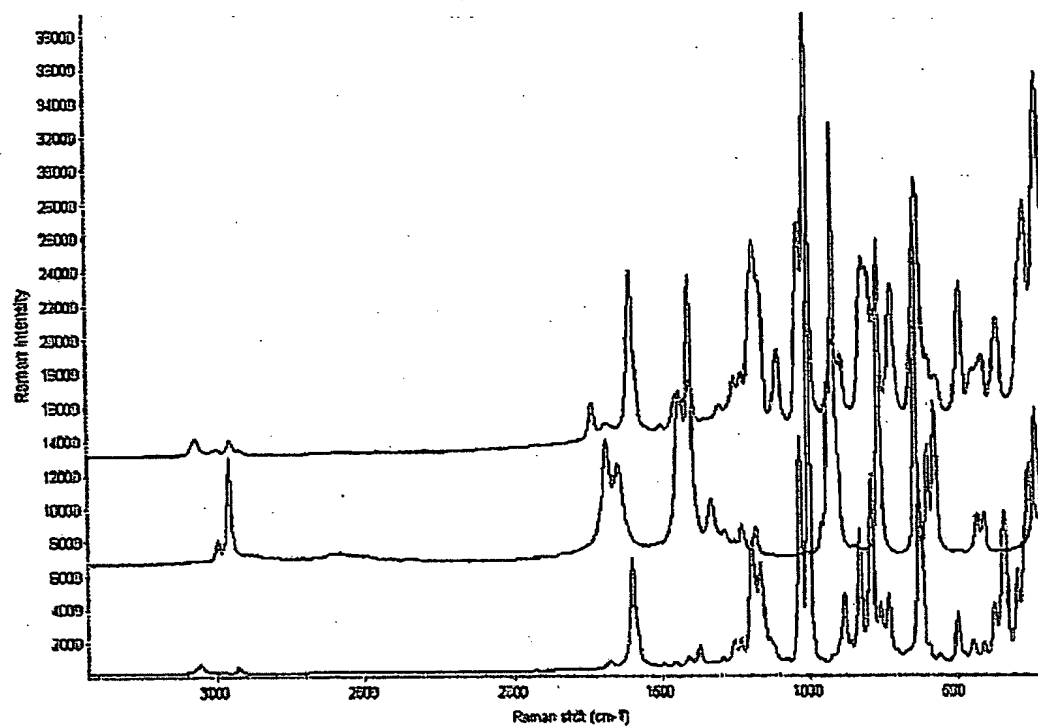
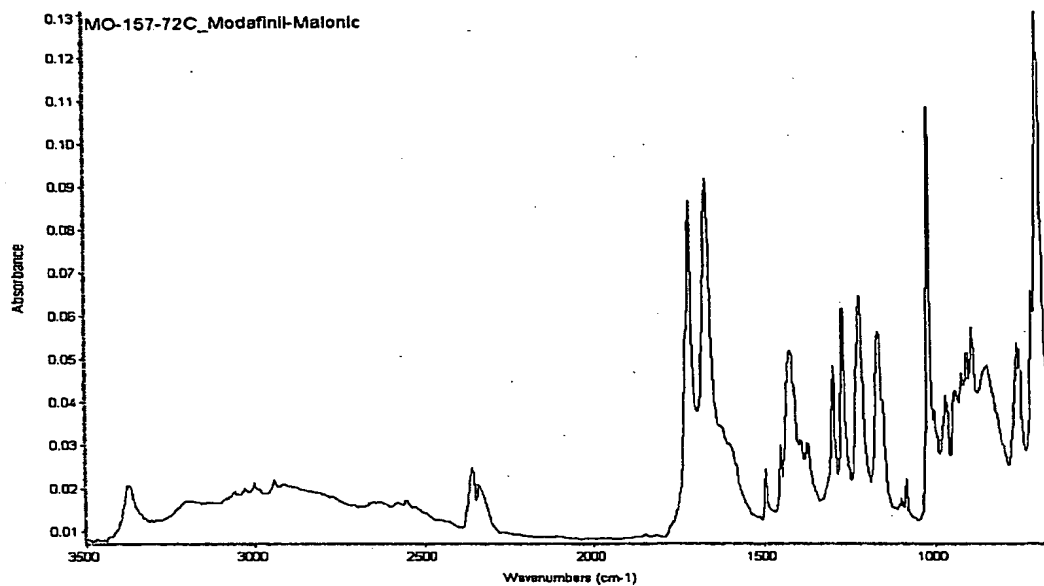


Figure 4B



Position:	700	Intensity:	0.131
Position:	1020	Intensity:	0.109
Position:	1668	Intensity:	0.0916
Position:	1718	Intensity:	0.0865
Position:	715	Intensity:	0.0664
Position:	1220	Intensity:	0.0647
Position:	1270	Intensity:	0.0624
Position:	892	Intensity:	0.0576
Position:	1164	Intensity:	0.0563
Position:	760	Intensity:	0.0538
Position:	655	Intensity:	0.0528
Position:	751	Intensity:	0.0527
Position:	1422	Intensity:	0.0518
Position:	907	Intensity:	0.0517
Position:	847	Intensity:	0.0485
Position:	1296	Intensity:	0.0482
Position:	921	Intensity:	0.0468
Position:	943	Intensity:	0.0428
Position:	969	Intensity:	0.0417
Position:	1004	Intensity:	0.0382
Position:	1372	Intensity:	0.0301
Position:	1451	Intensity:	0.0303
Position:	2360	Intensity:	0.0245
Position:	1496	Intensity:	0.0242
Position:	1086	Intensity:	0.0218
Position:	2942	Intensity:	0.0216
Position:	3001	Intensity:	0.0210
Position:	2342	Intensity:	0.0205
Position:	3372	Intensity:	0.0203

Figure 5A



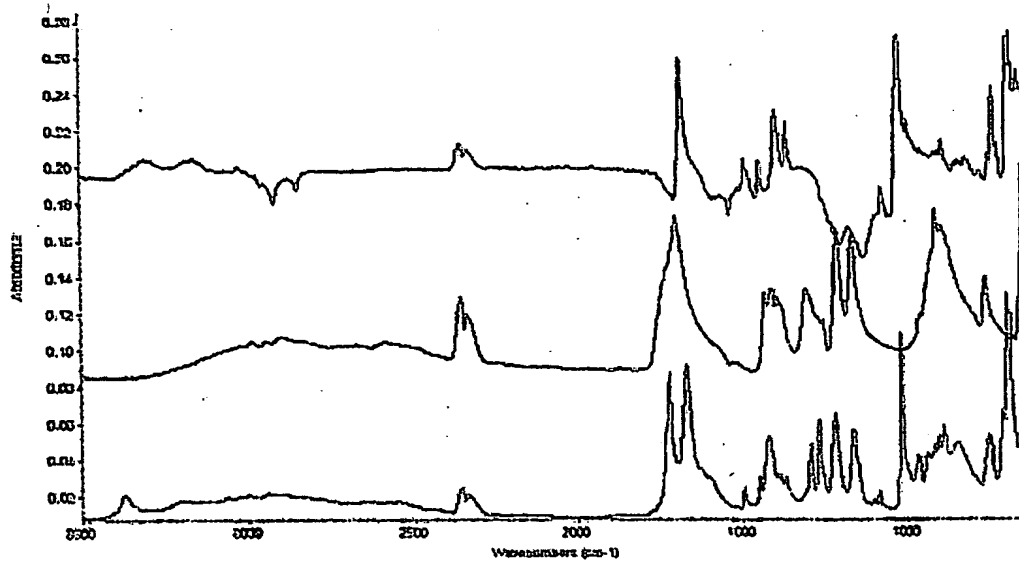


Figure 5B

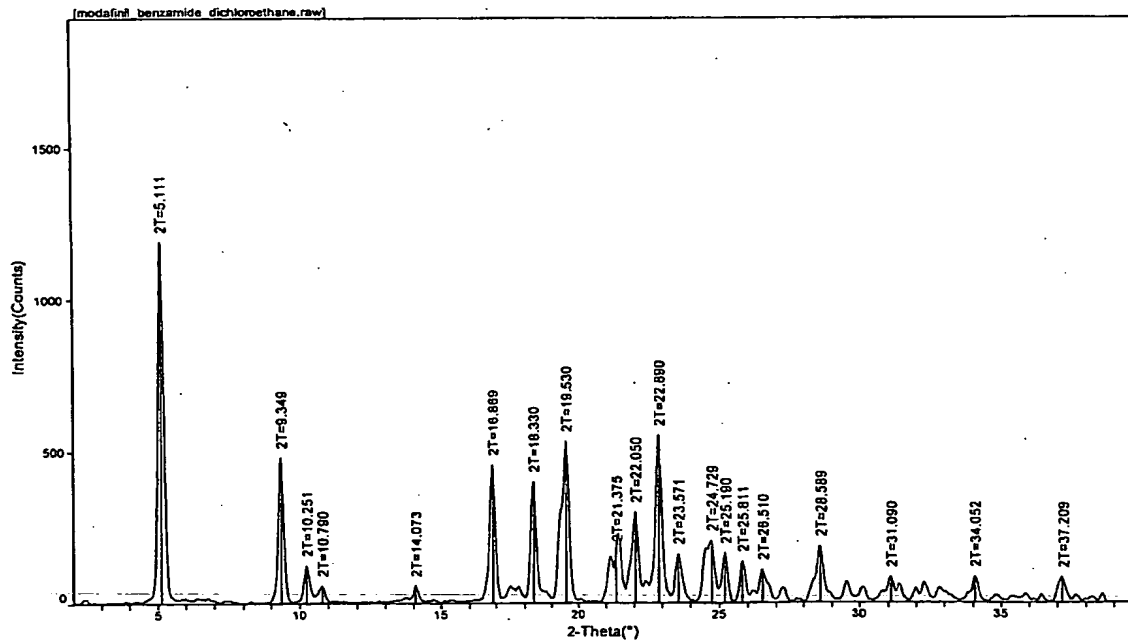


Figure 6

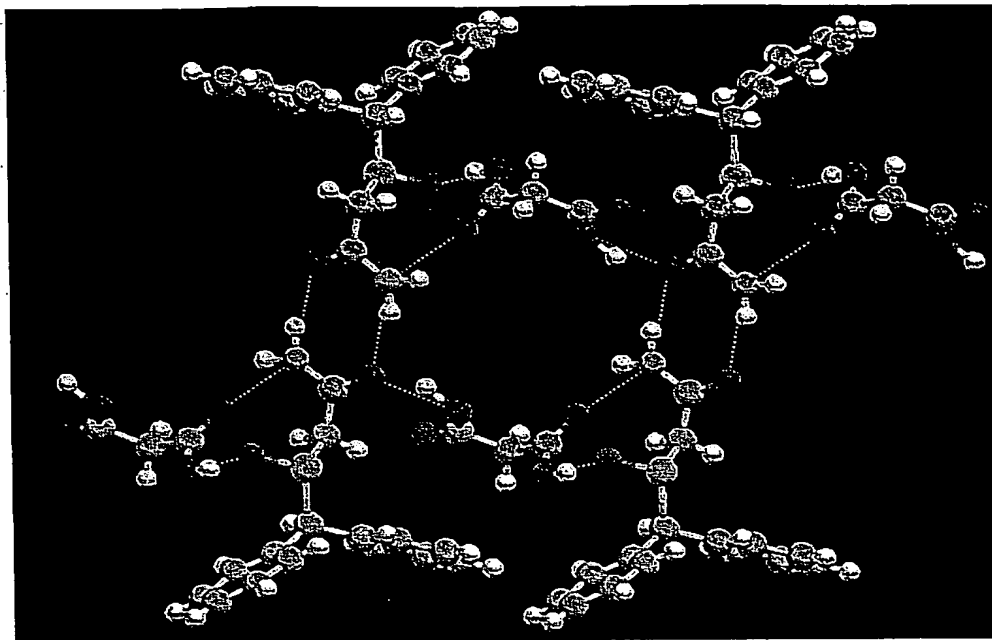


Figure 7

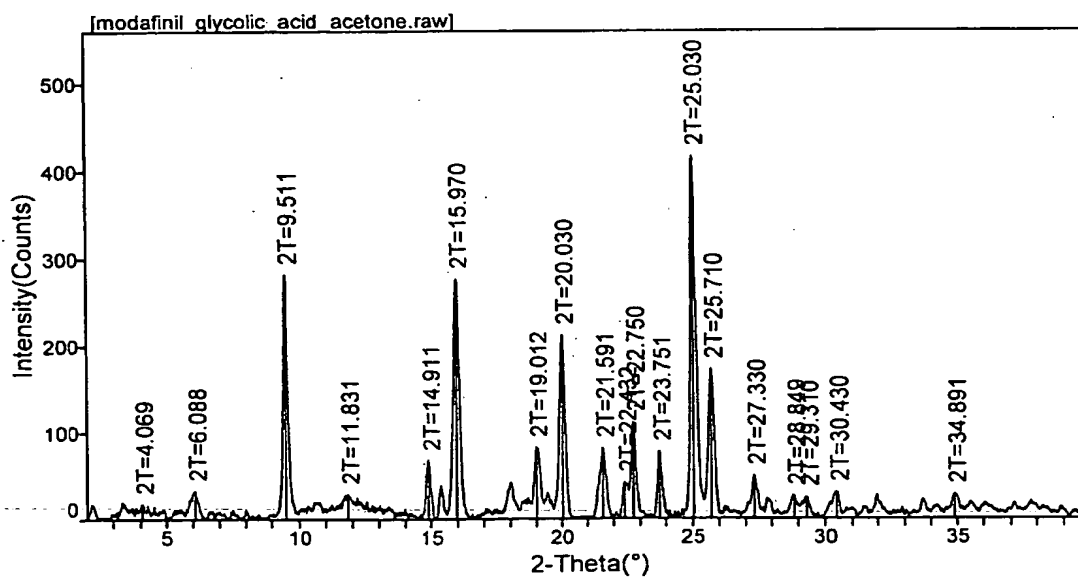


Figure 8A

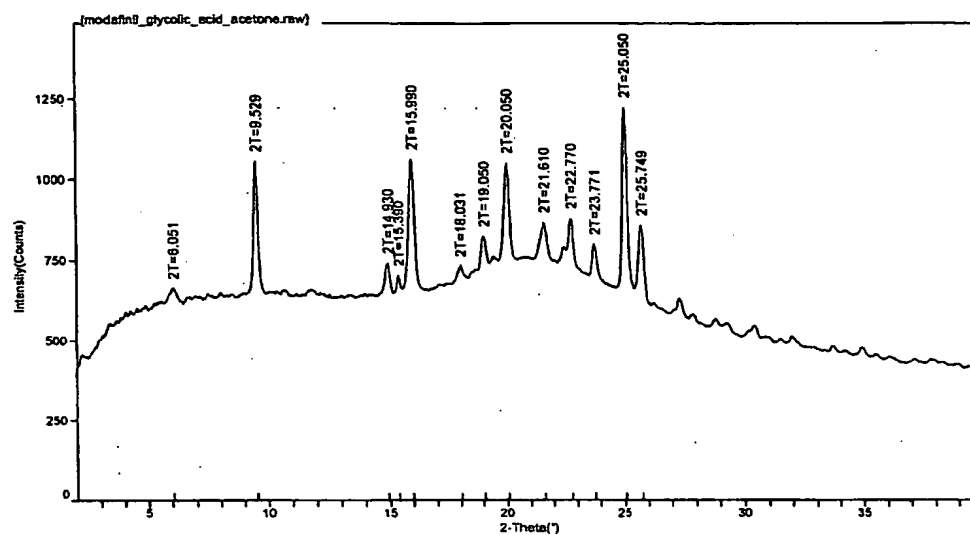


Figure 8B

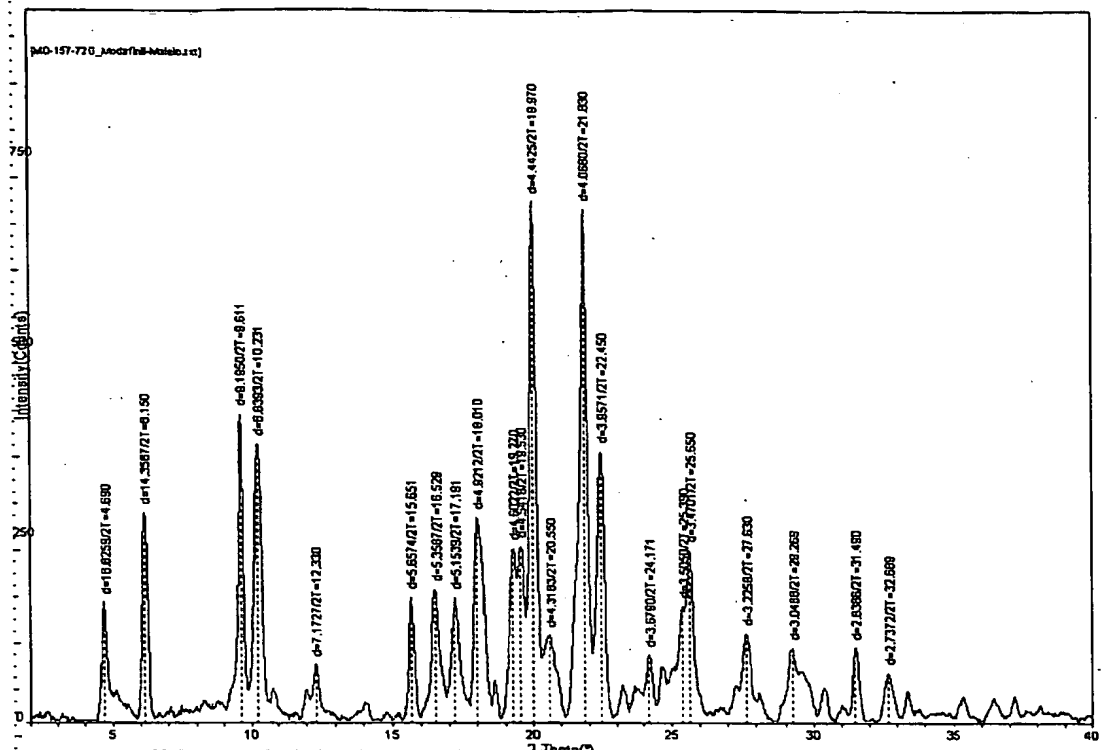


Figure 9A

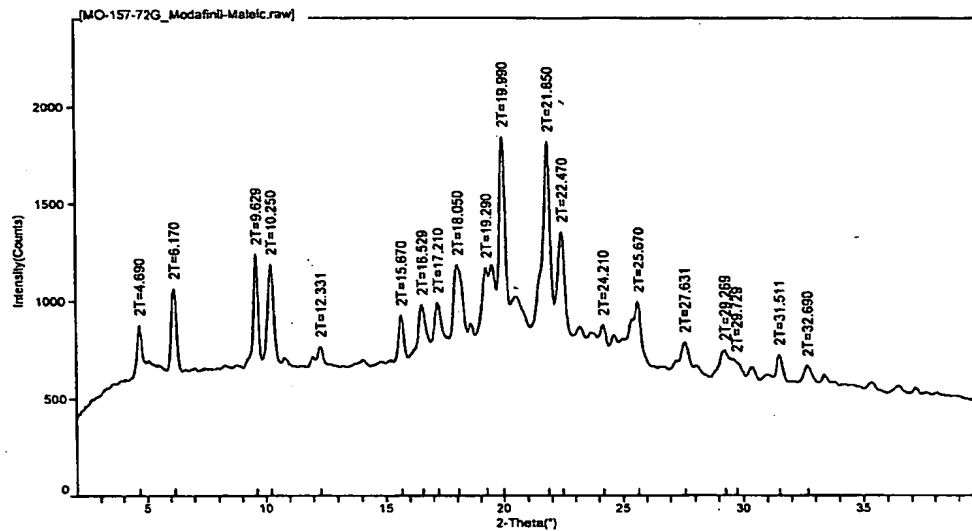
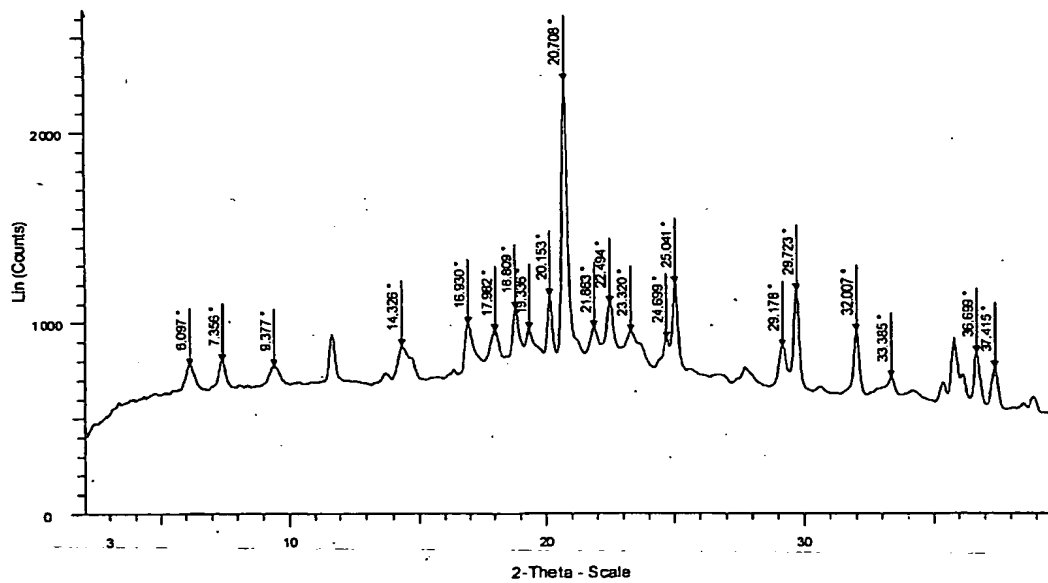
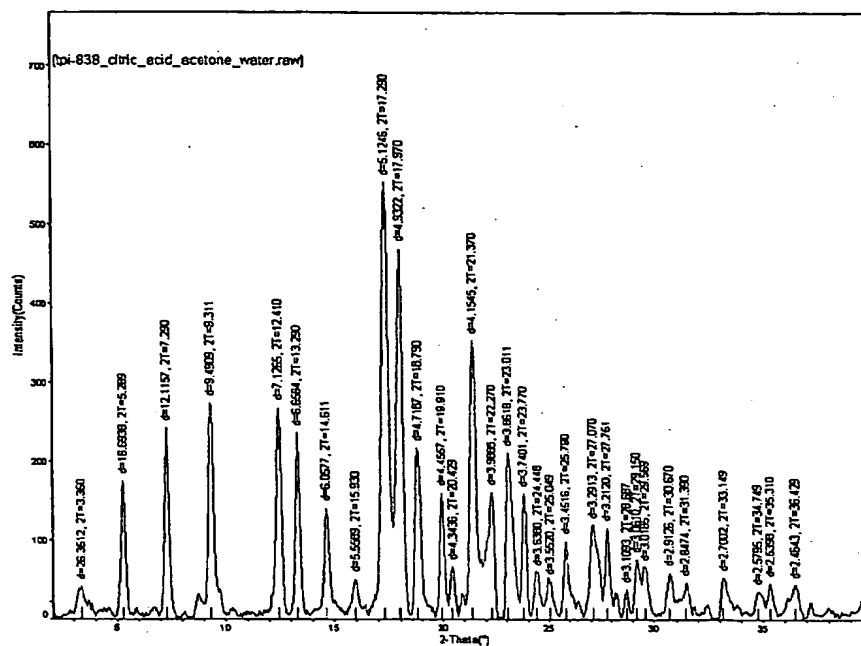


Figure 9B



File: CMAX1360\_Block54\_E1FromJade.raw

Figure 10



Materials Data, Inc.

Figure 11

File: 01-838\_citric\_acid\_acetone\_water.raw

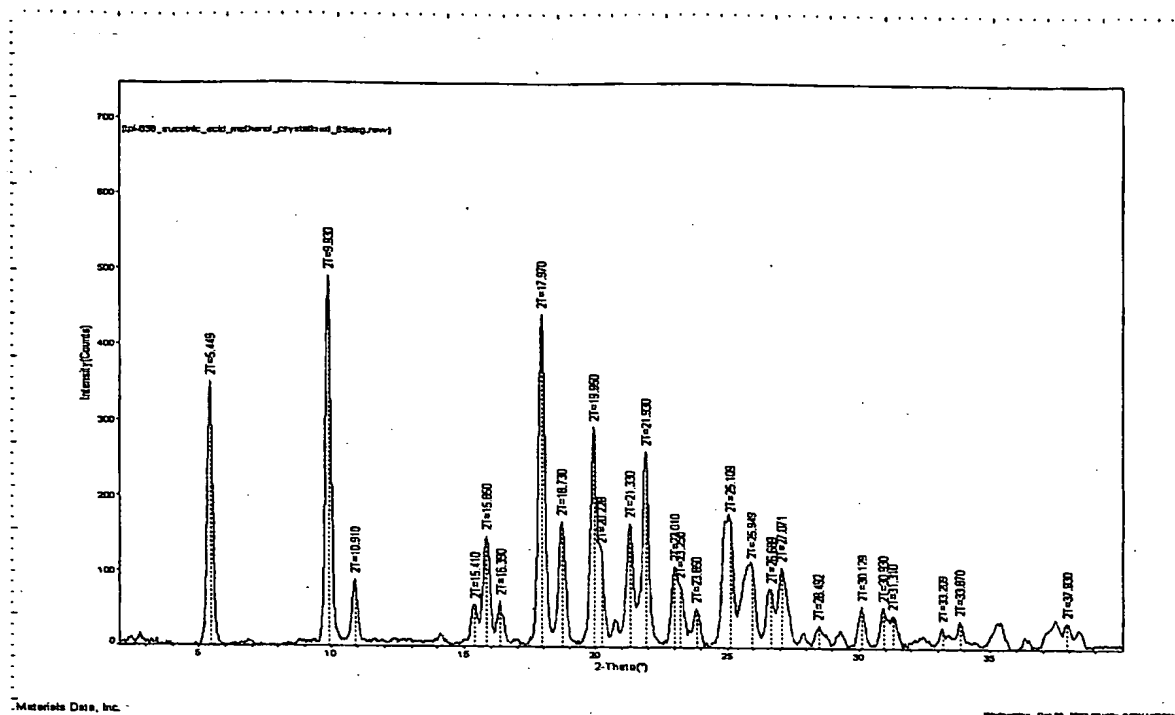


Figure 12A

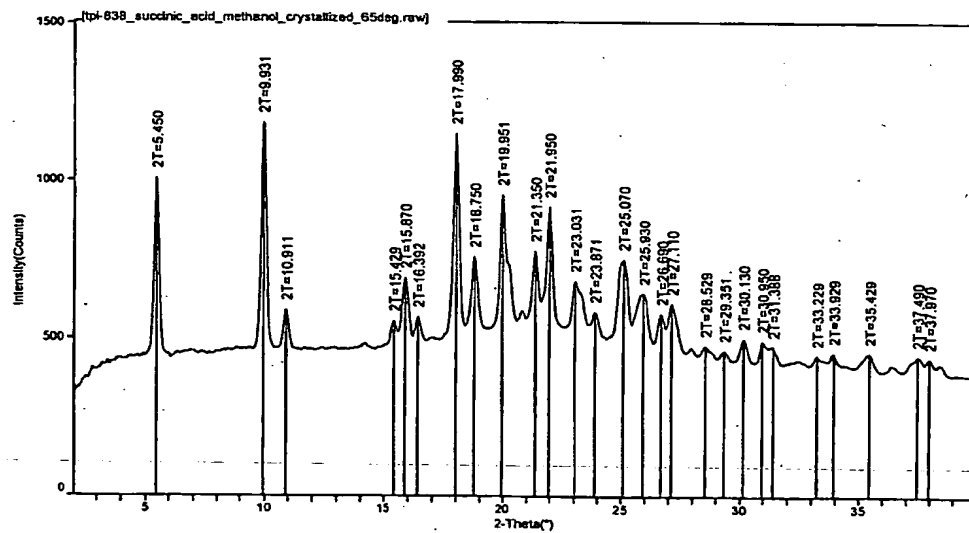


Figure 12B

Sample: MO-210-3\_838-Succinic\_Rotary DSC File: V:\MO-210-3\_838-Succin  
 Size: 1.6530 mg Operator: MAO  
 Method: Ramp Run Date: 13-Nov-03 14:40

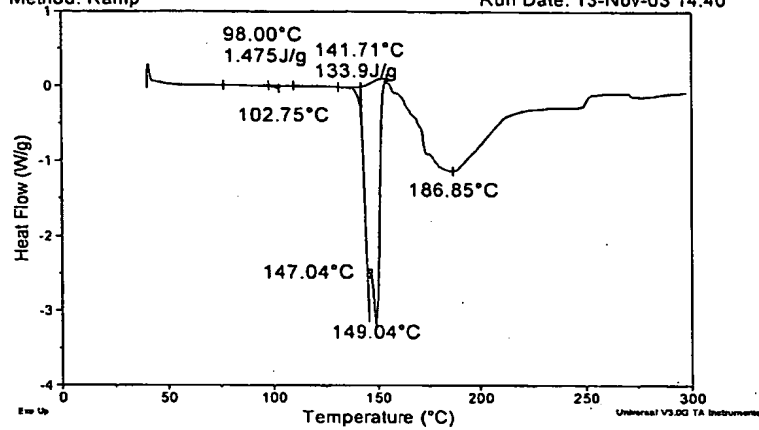


Figure 13

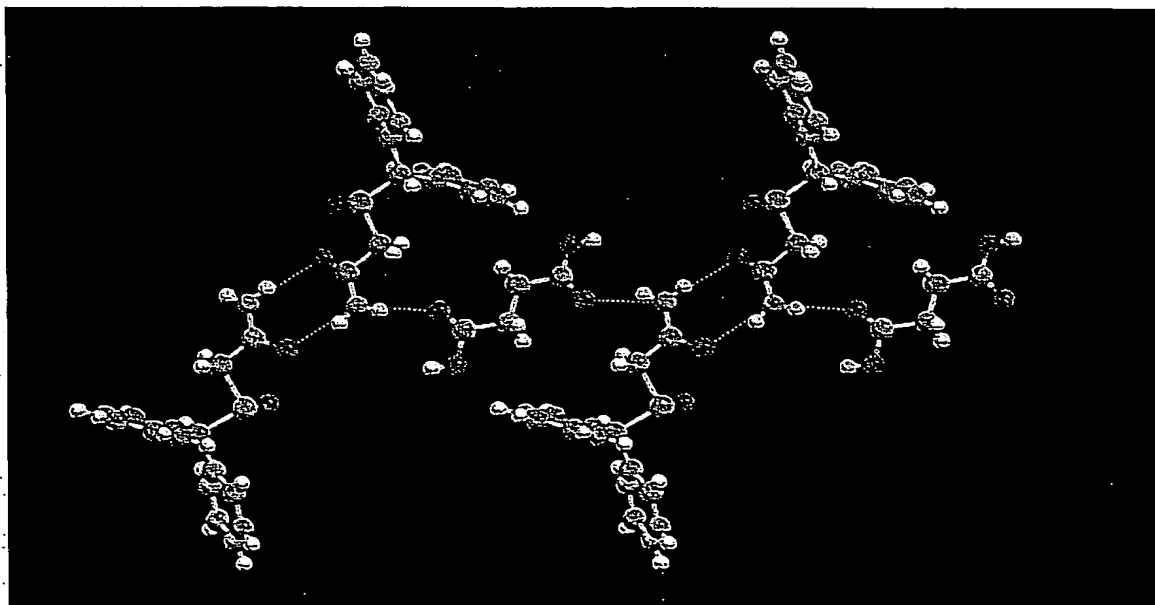


Figure 14



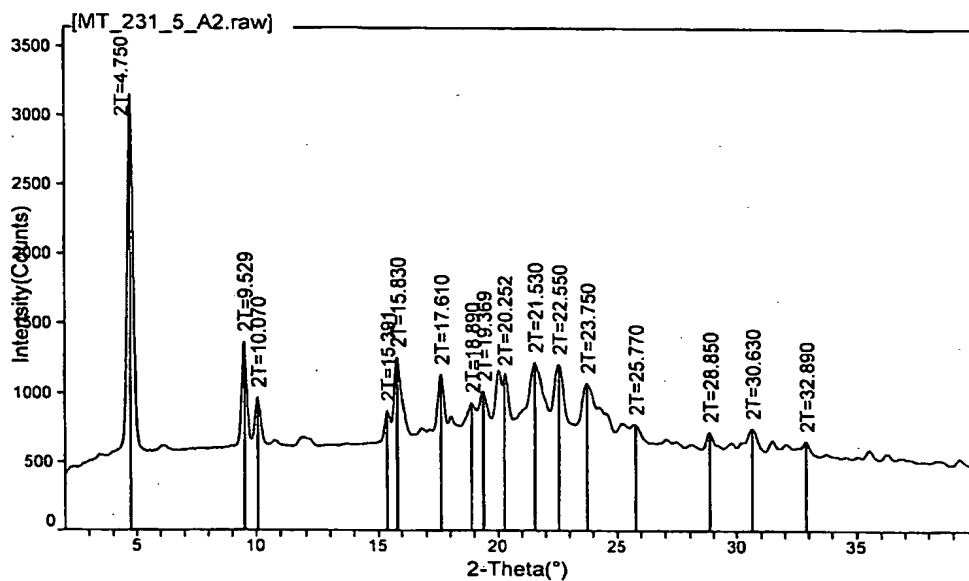


Figure 15

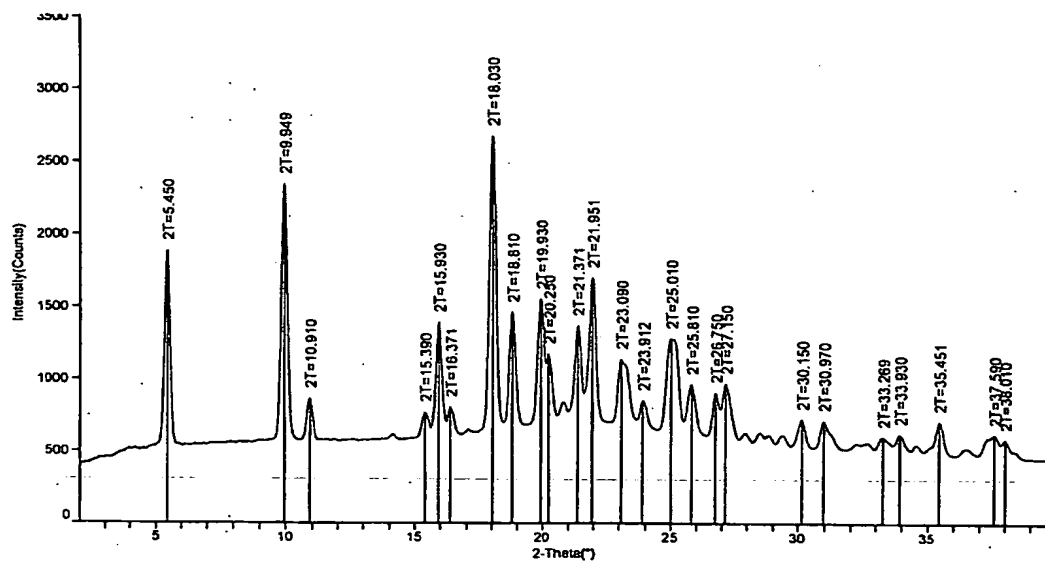
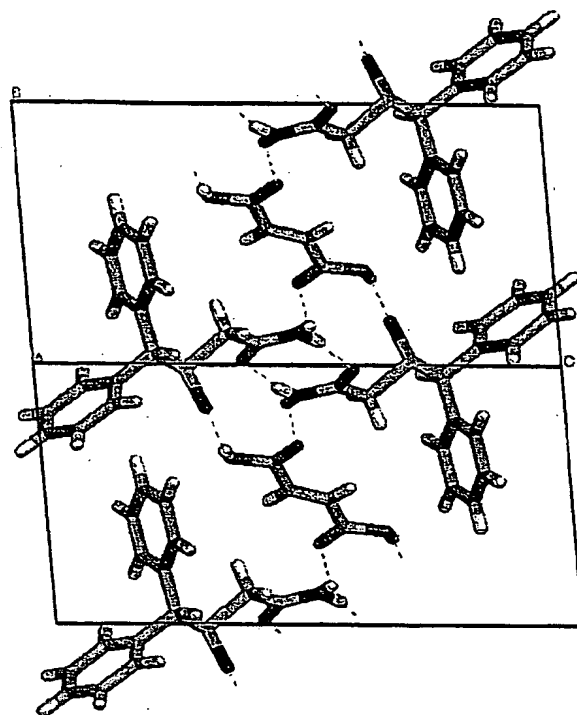


Figure 16



Y  
L<sub>2</sub>

Figure 17

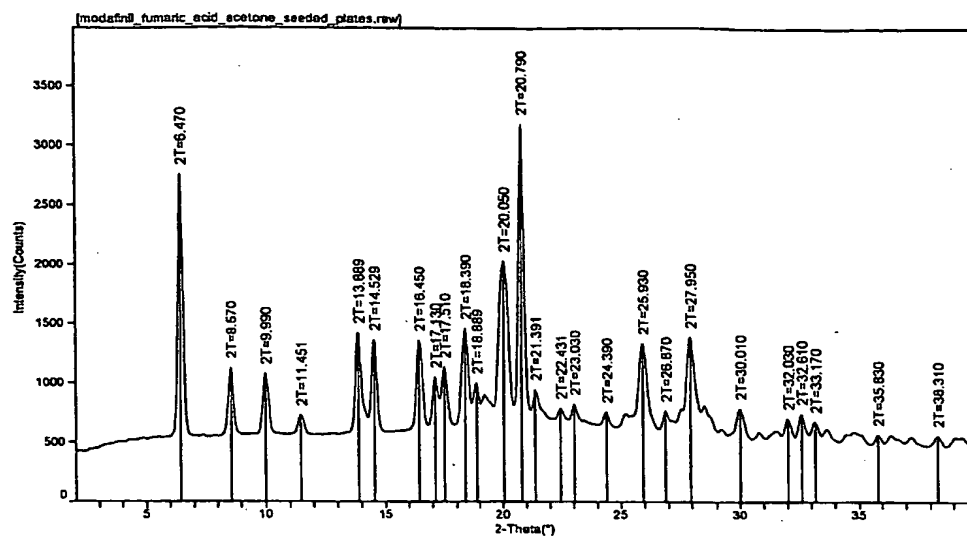


Figure 18

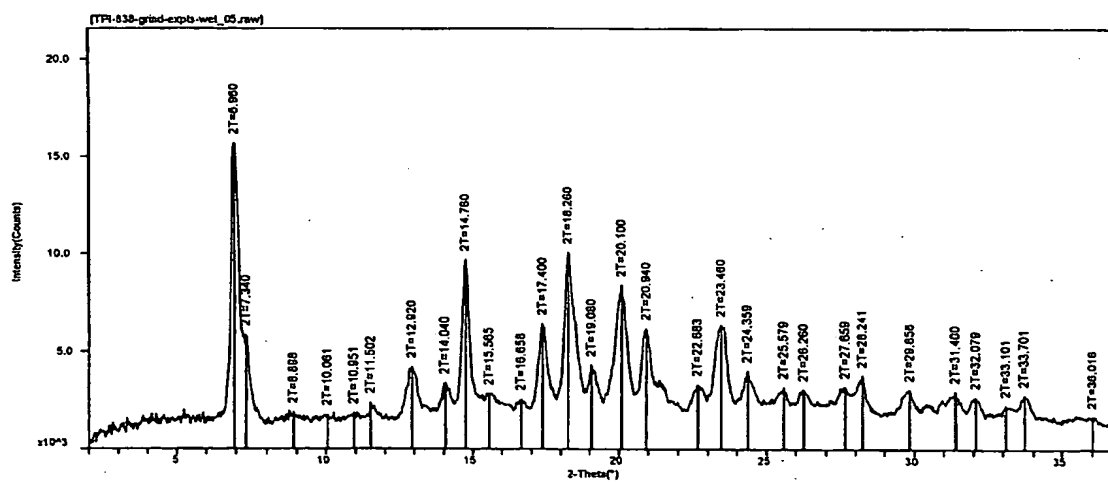


Figure 19

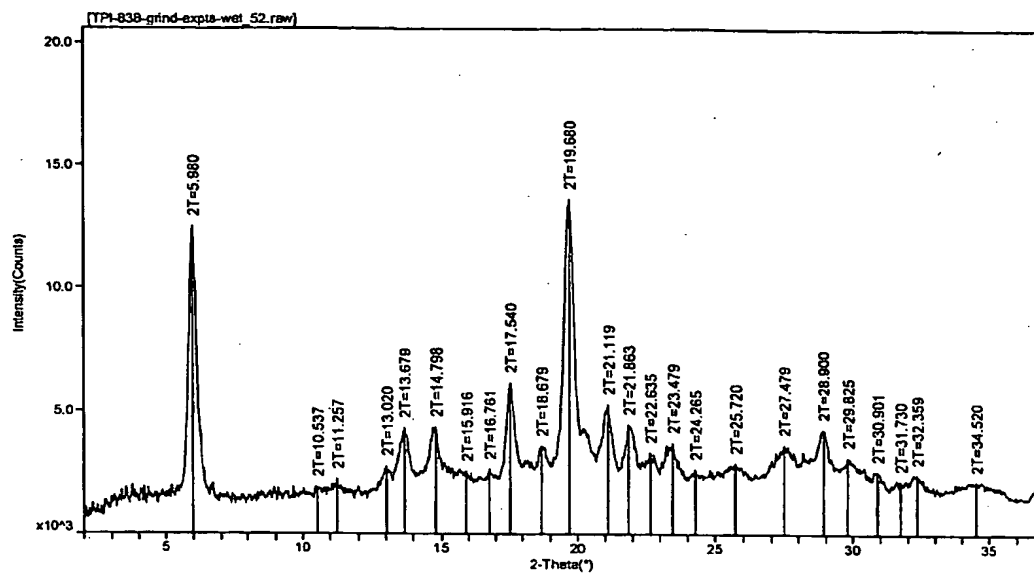


Figure 20

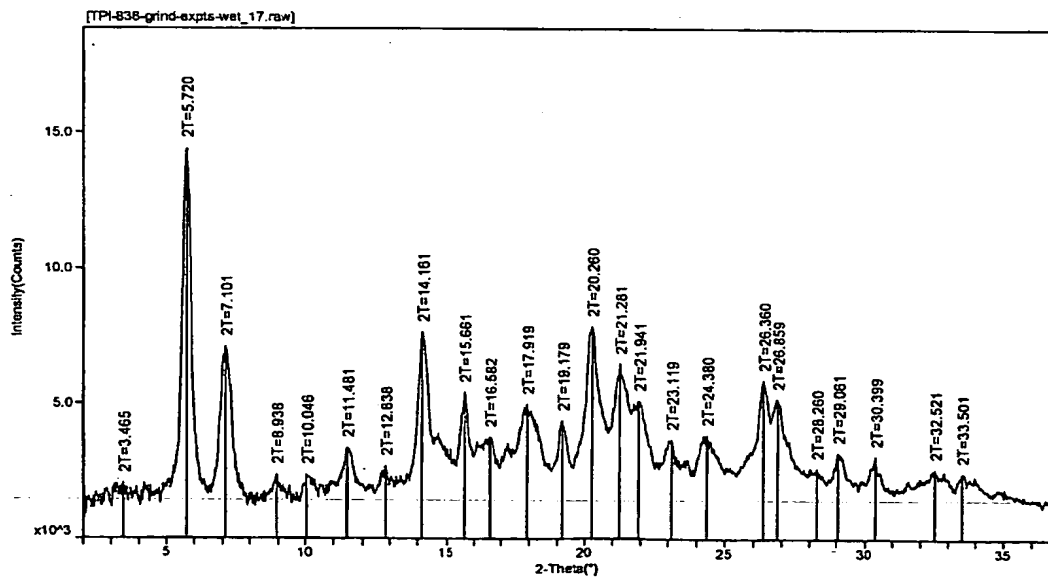


Figure 21

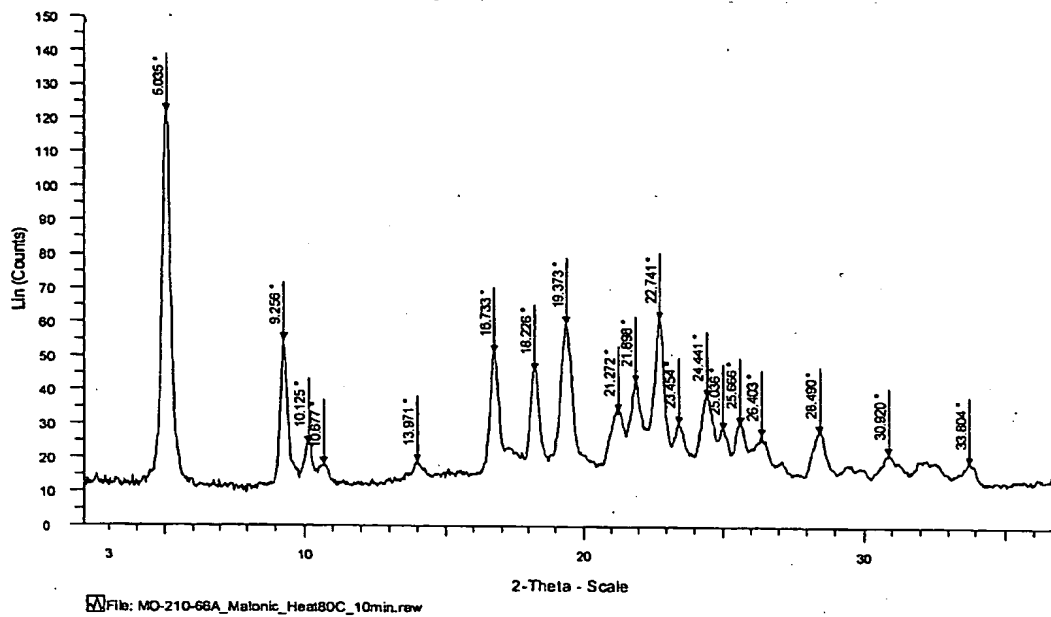


Figure 22

### DSC

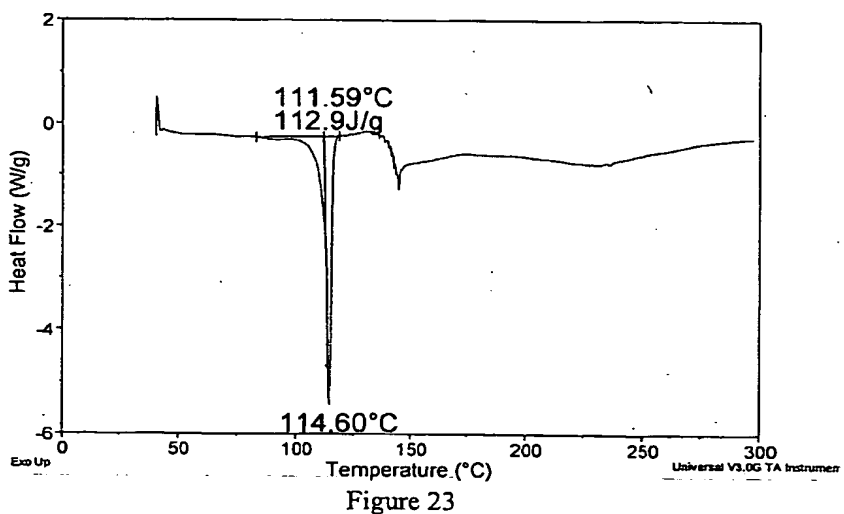


Figure 23

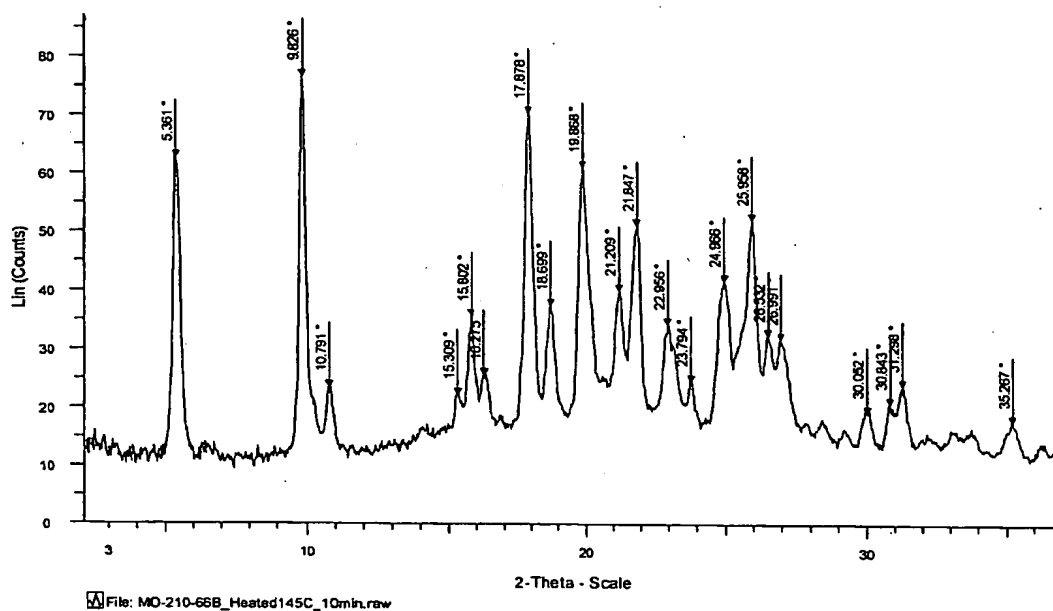


Figure 24

### DSC

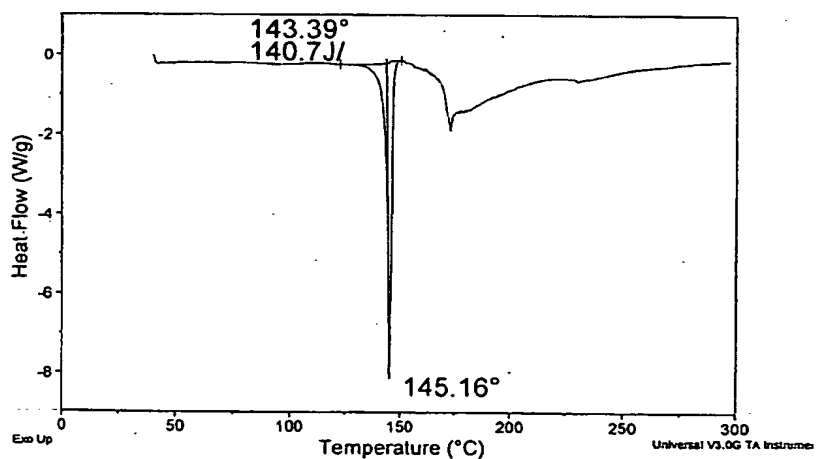


Figure 25

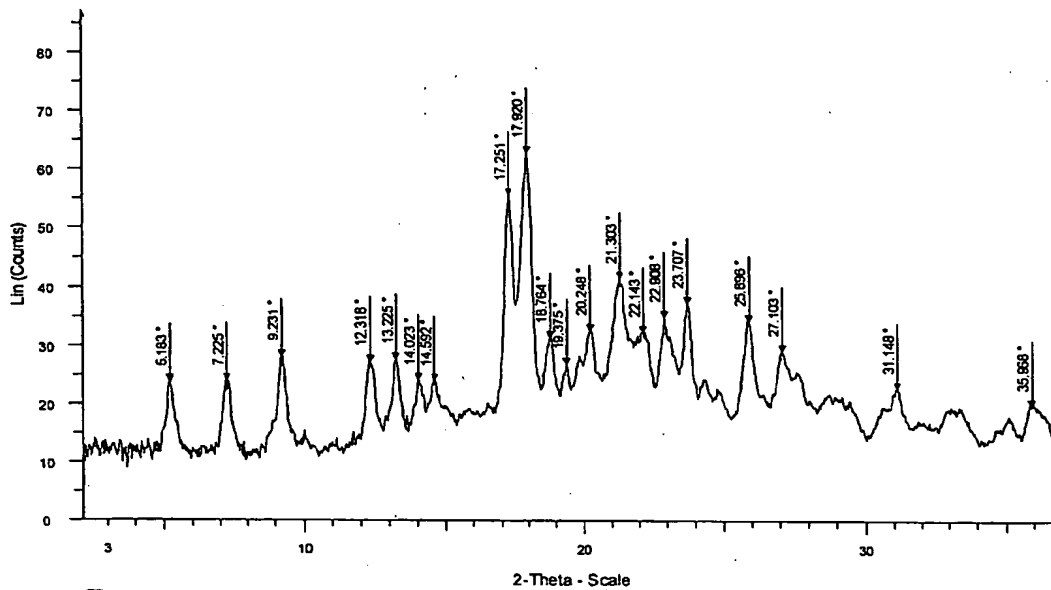


Figure 26

Sample: MO-210-66C\_CitricCC  
 Size: 1.5090 mg  
 Method: Ramp

DSC

File: V:\Modafinil\MO-210-66C  
 Operator: MAO  
 Run Date: 28-Jan-04 11:28

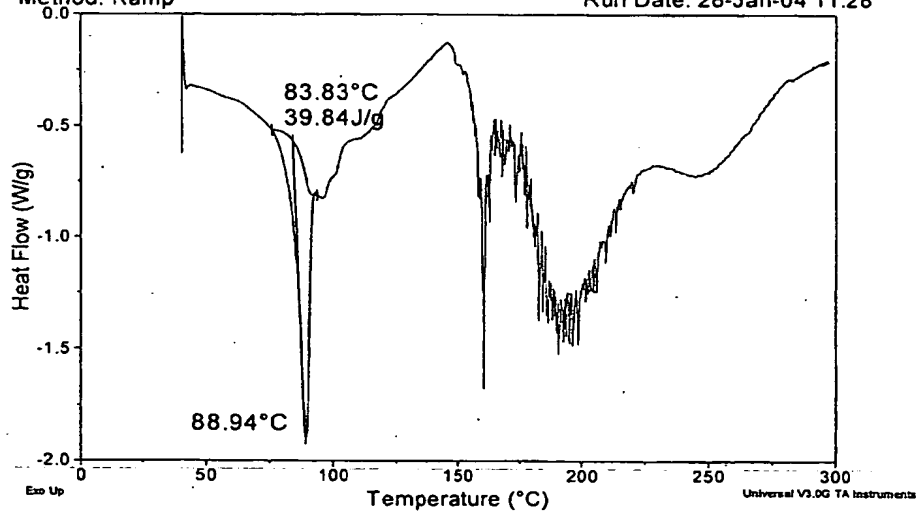


Figure 27

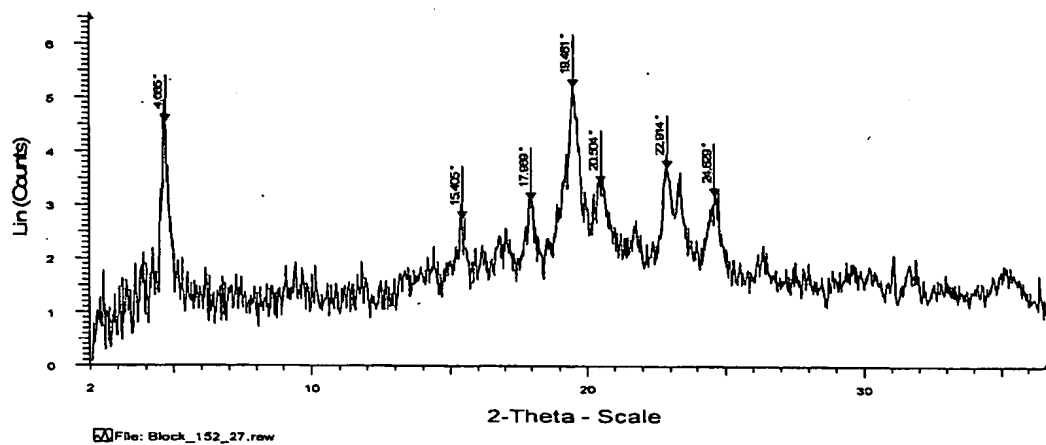


Figure 28

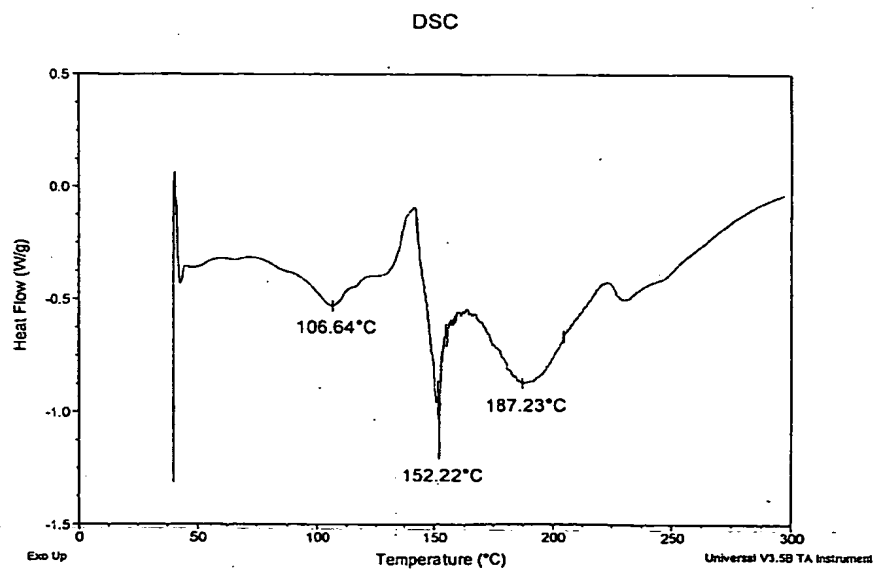


Figure 29



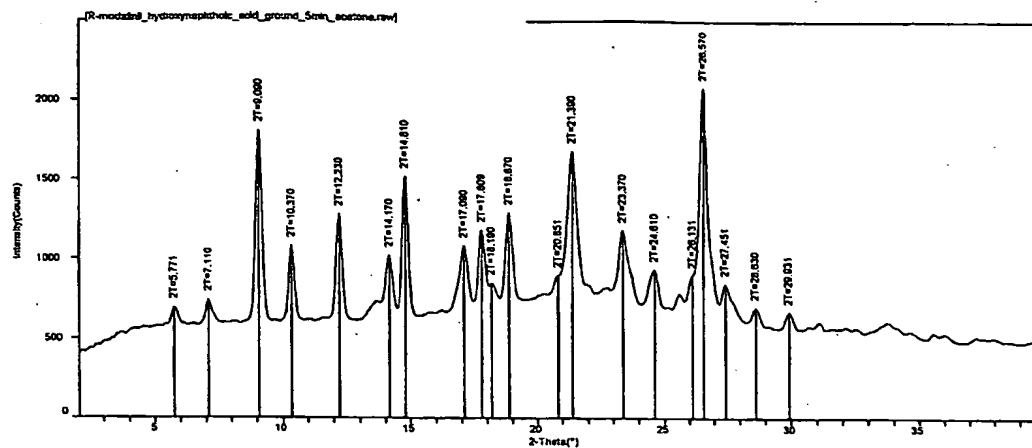


Figure 30

DSC

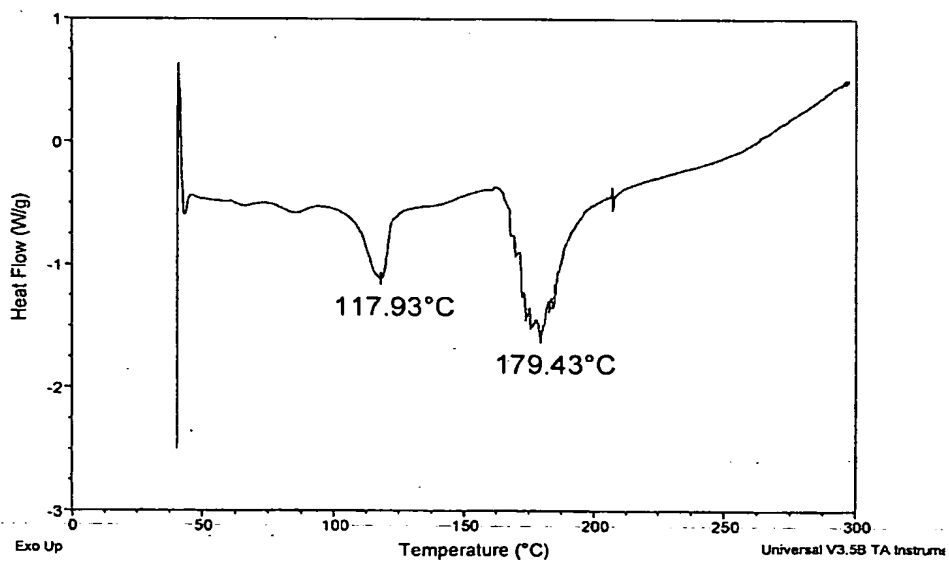


Figure 31

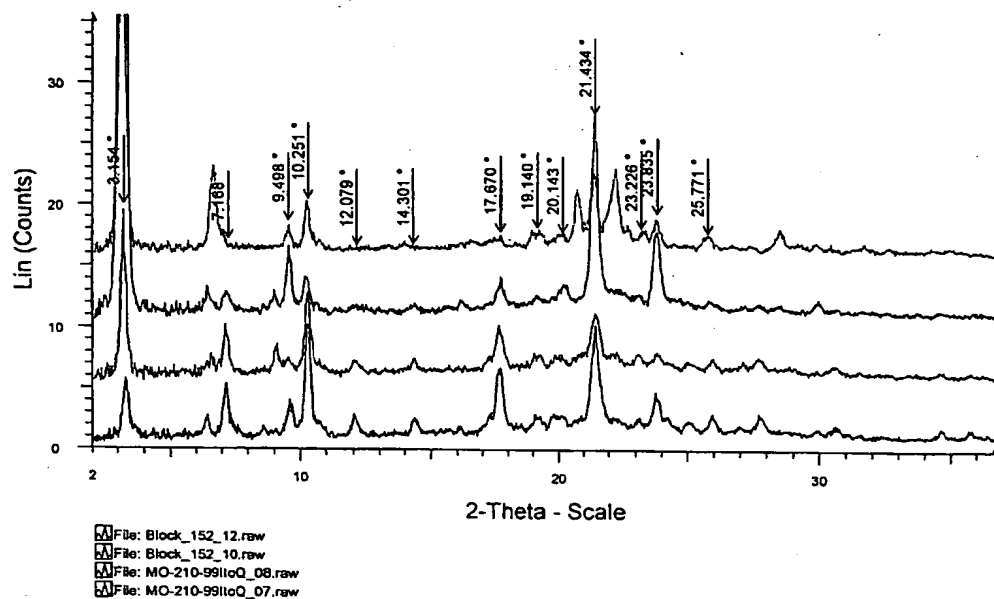


Figure 32

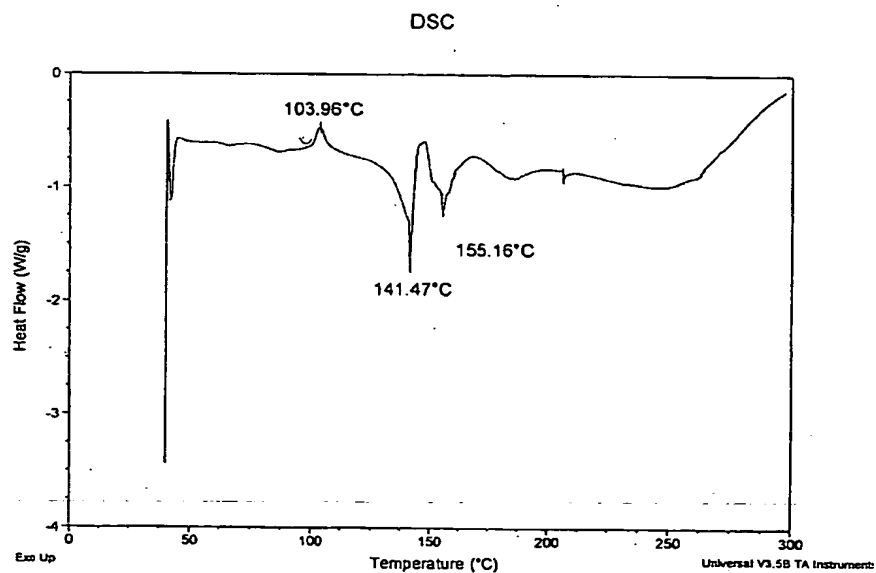


Figure 33

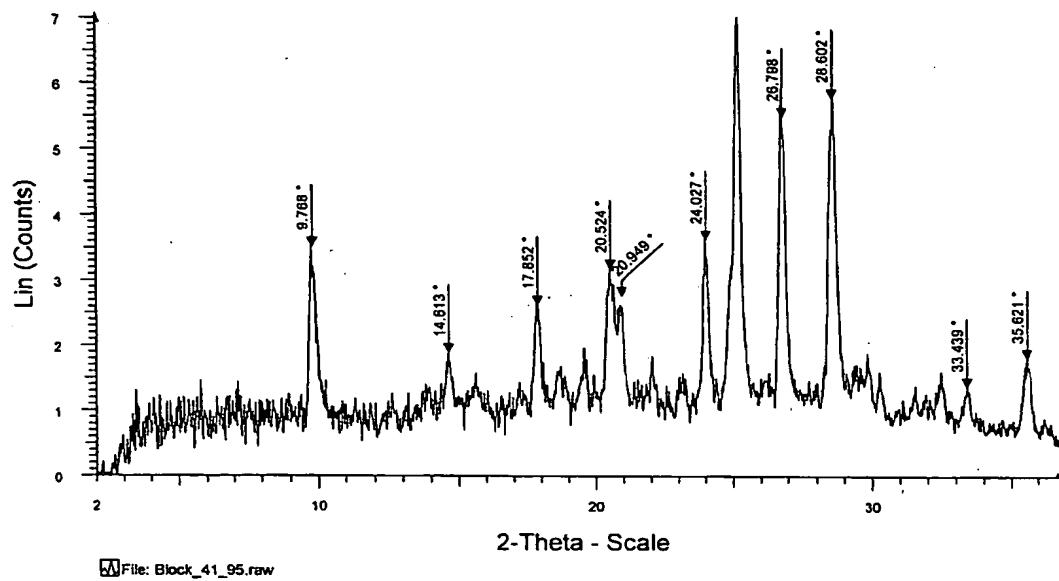


Figure 34

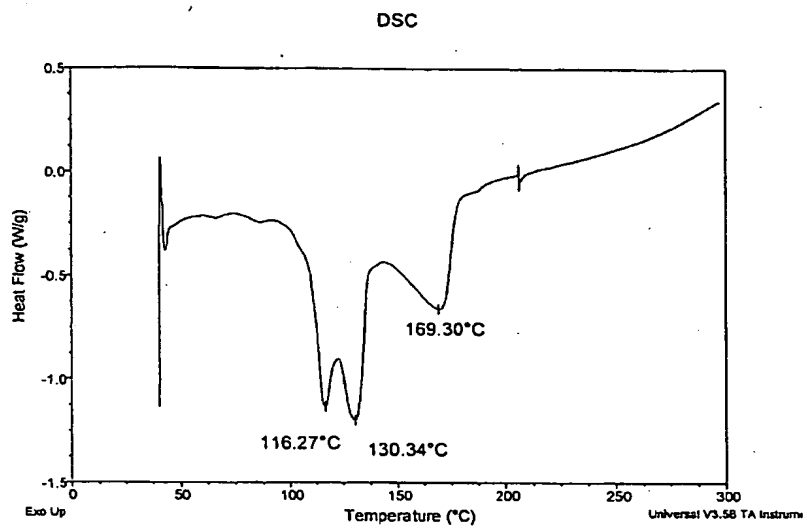
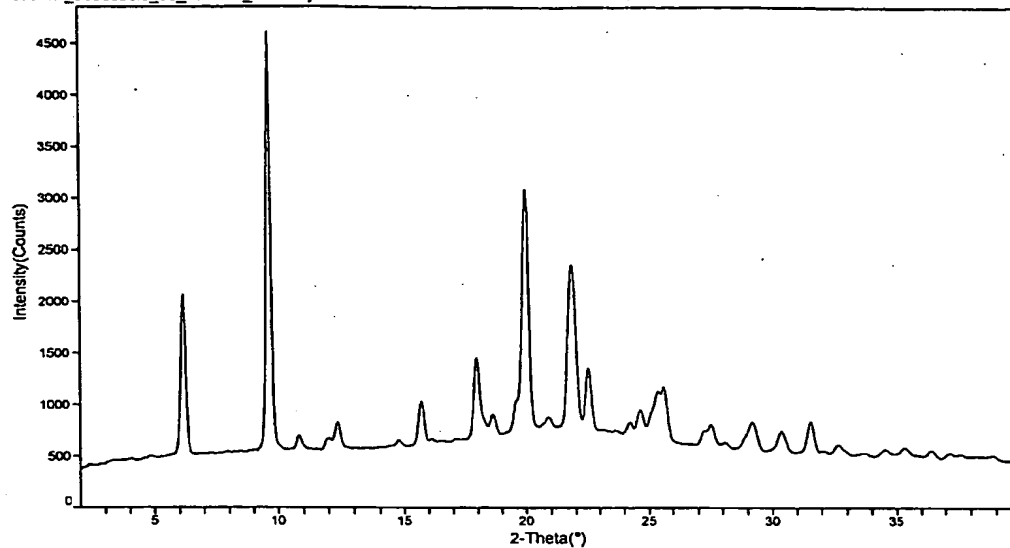


Figure 35

[Modafinil\_aceticacid\_su\_073103\_SS.raw]



2-Theta Degrees
6.169
9.629
10.810
11.990
12.349
14.771
15.690
17.970
18.610
19.990
20.929
21.830
22.510
24.248
24.669
25.611
27.569
28.093
29.190
30.390

Figure 36

Sample: B04m01\_0010\_070303\_05  
Ct: 0.9220 mg  
Method: Ramp

# TGA

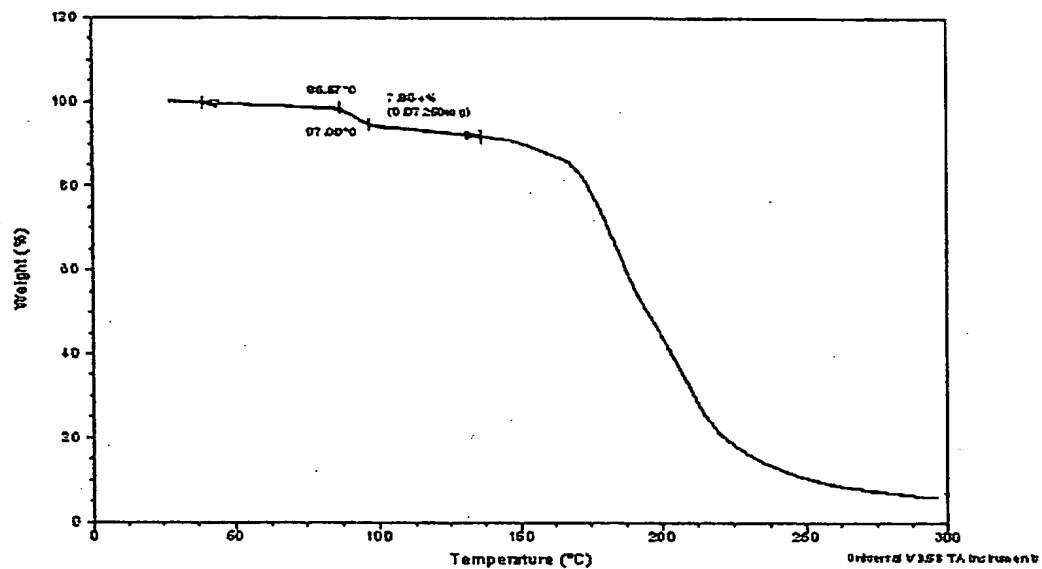


Figure 37

Sample : m00arh11aovt03 072303 SS  
Size : 0.5200 mg  
Method: Ramp

DSC

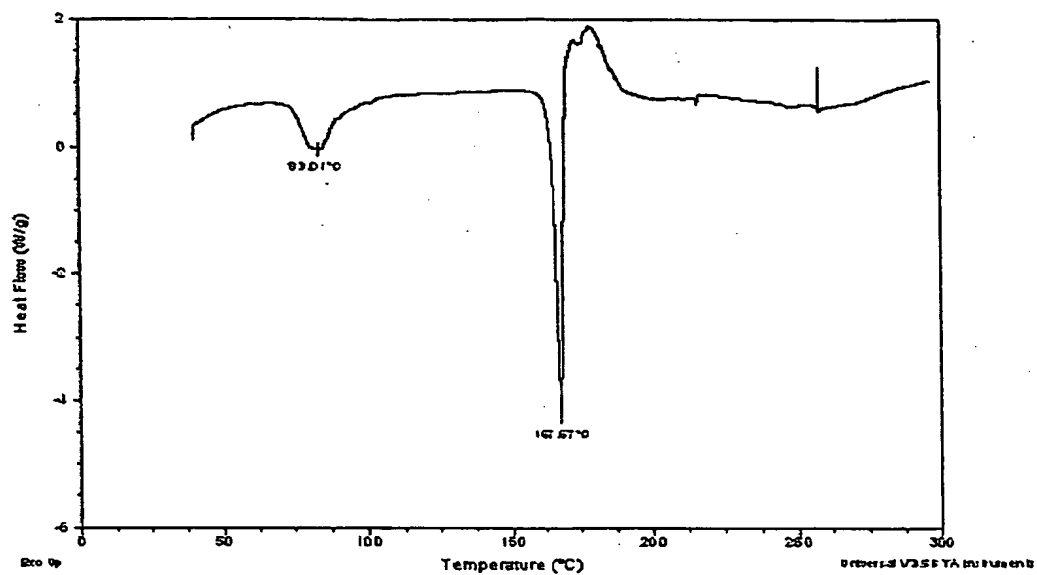
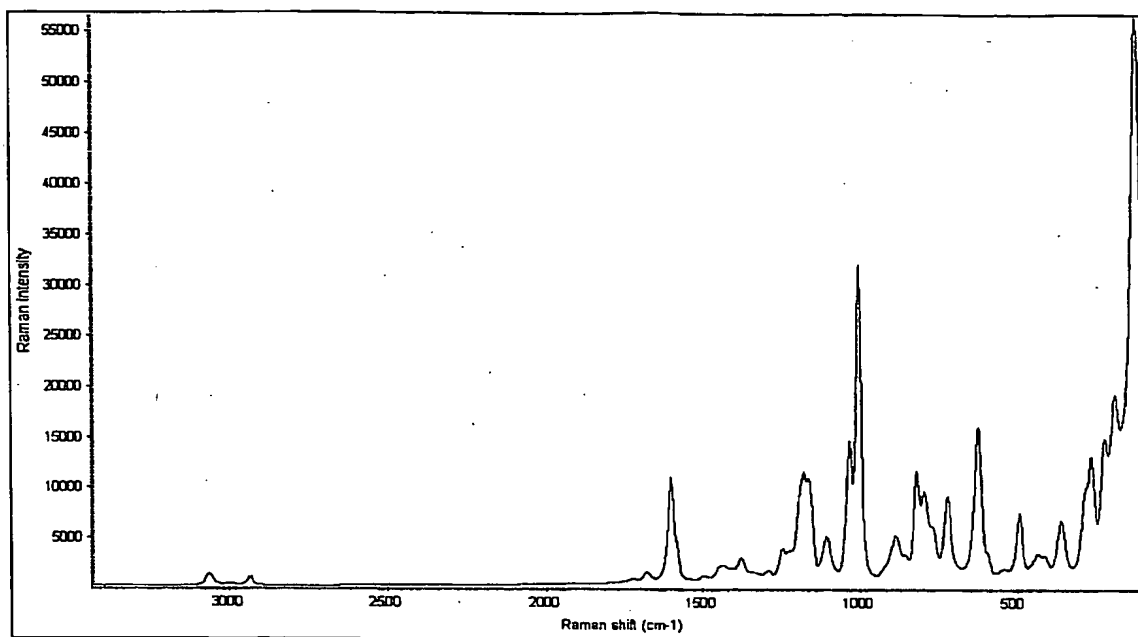


Figure 38



Position:	124.38	Intensity:	56488.199
Position:	1003.39	Intensity:	32065.602
Position:	190.78	Intensity:	19242.451
Position:	624.92	Intensity:	16043.604
Position:	1032.16	Intensity:	14613.689
Position:	267.46	Intensity:	13128.612
Position:	822.14	Intensity:	11636.112
Position:	1181.06	Intensity:	11607.680
Position:	1601.13	Intensity:	11005.503
Position:	725.91	Intensity:	9152.309
Position:	494.61	Intensity:	7458.328
Position:	362.59	Intensity:	6747.720
Position:	887.40	Intensity:	5256.710
Position:	1106.67	Intensity:	5119.203

Figure 39



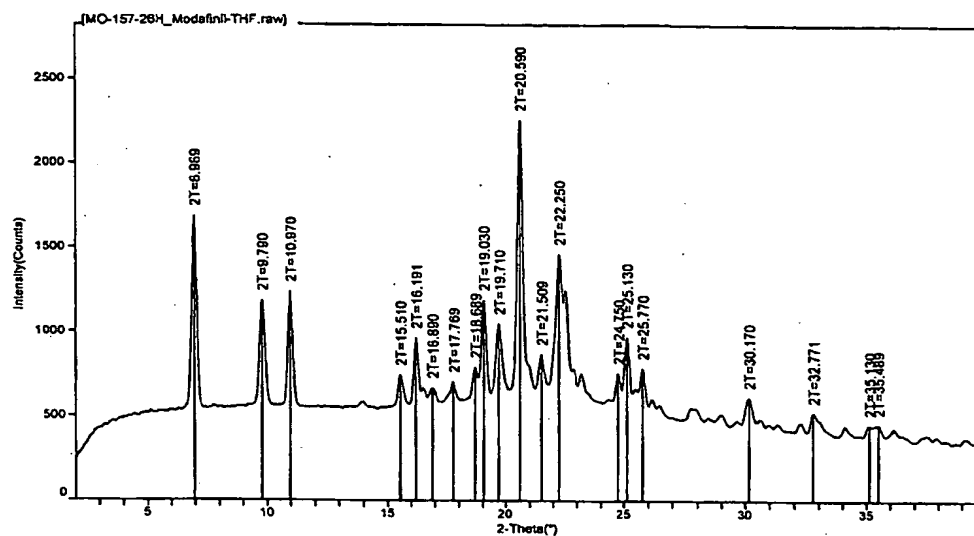


Figure 40

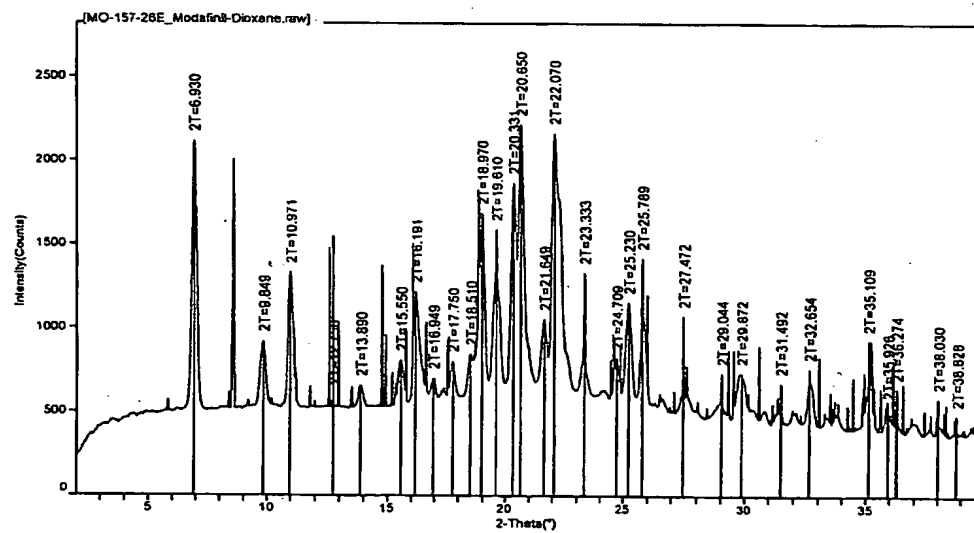


Figure 41

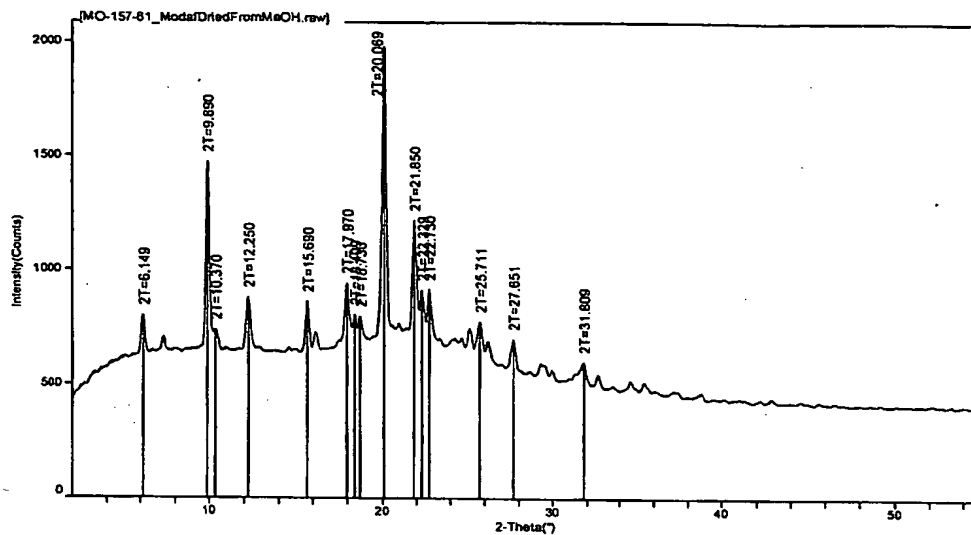


Figure 42

### TGA

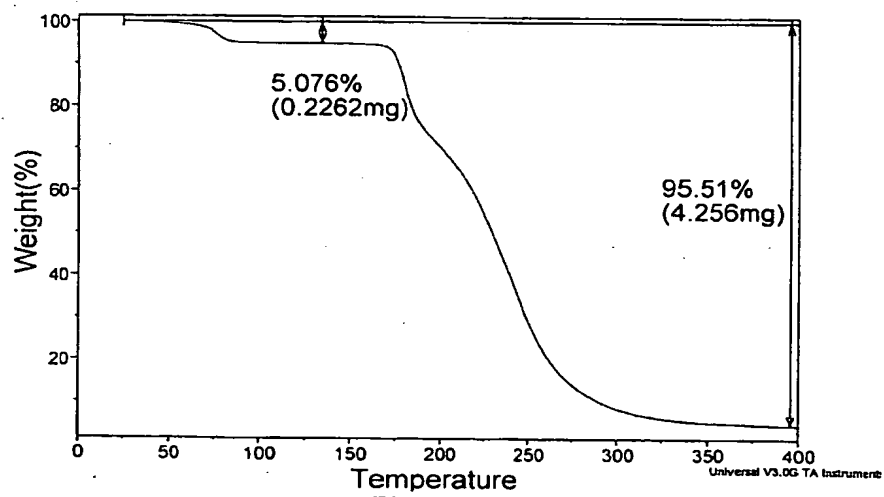


Figure 43

# DSC

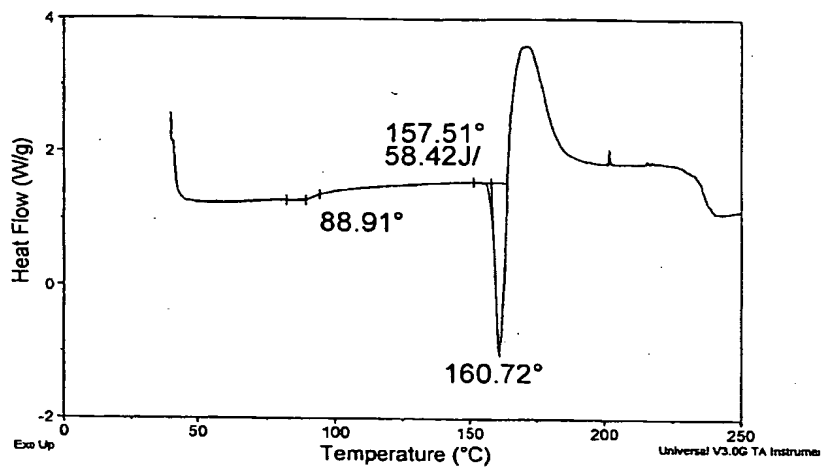


Figure 44

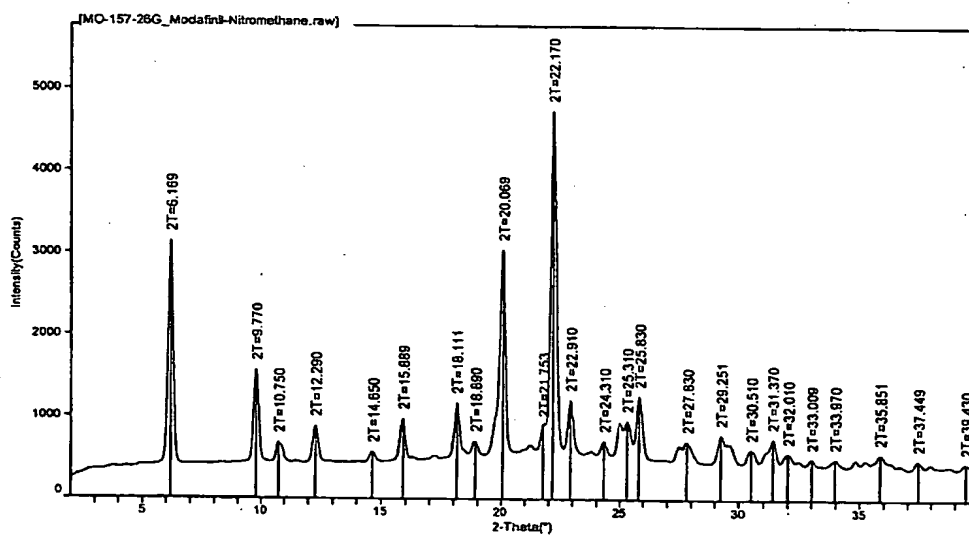


Figure 45

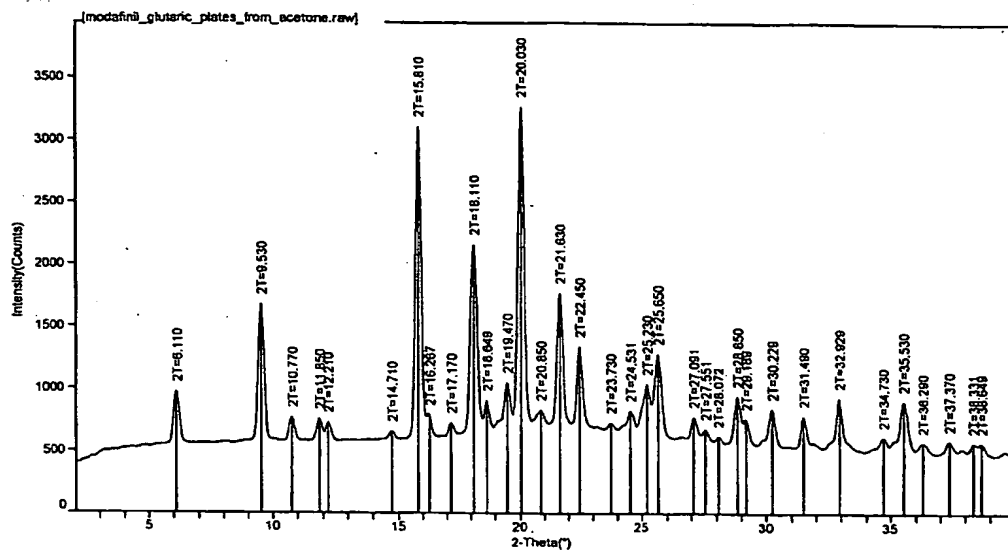


Figure 46

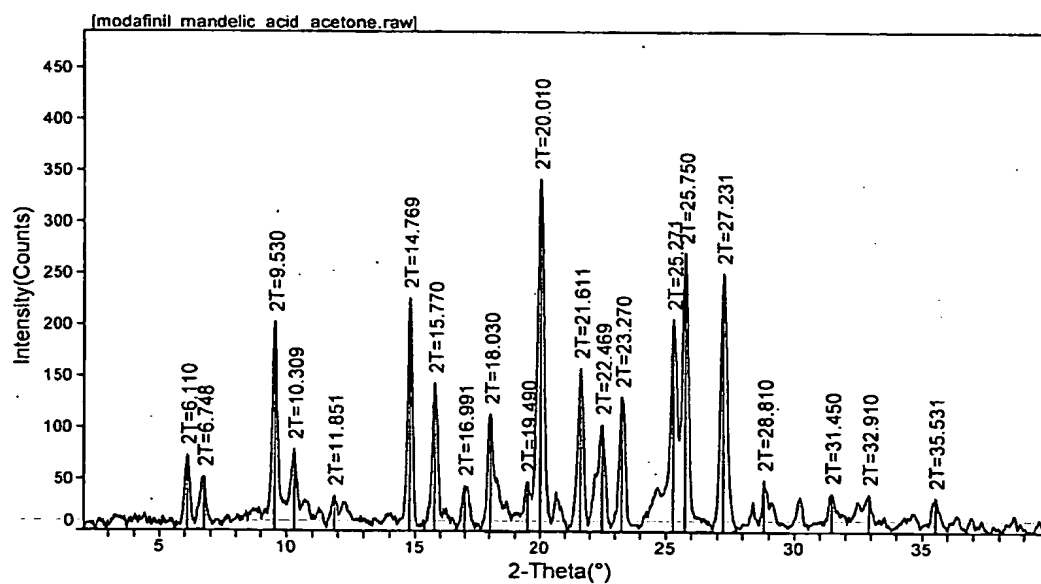


Figure 47

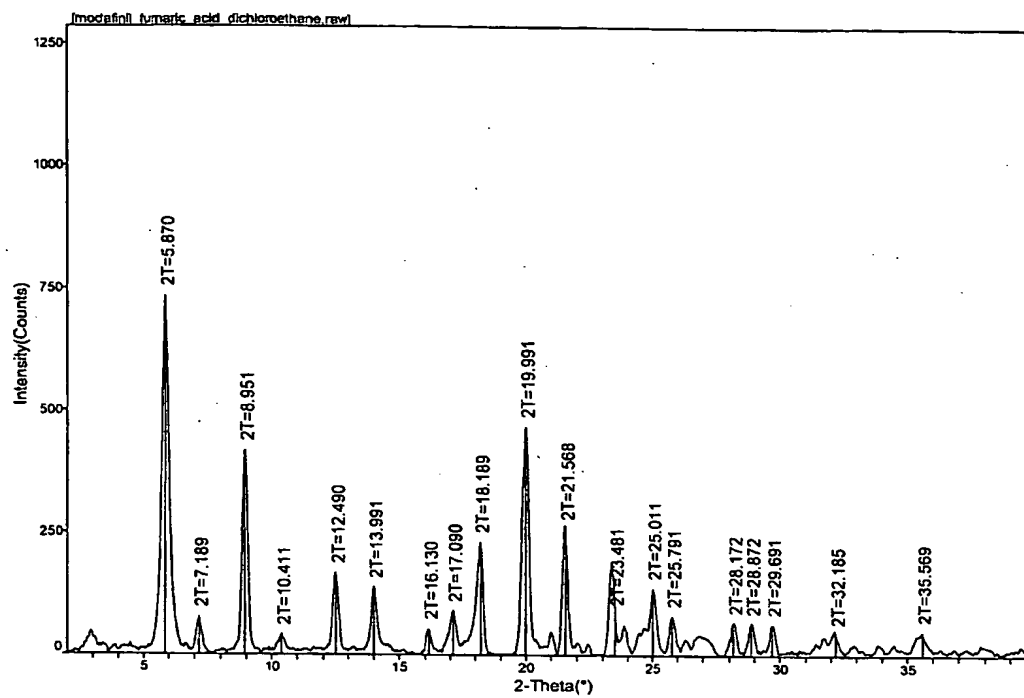


Figure 48

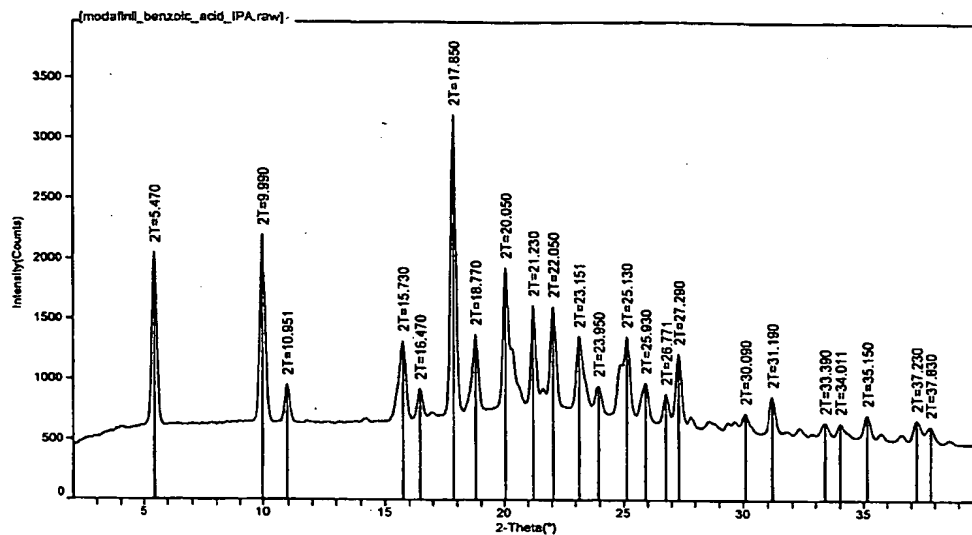


Figure 49

% Area degradants in TPI-838:malonic

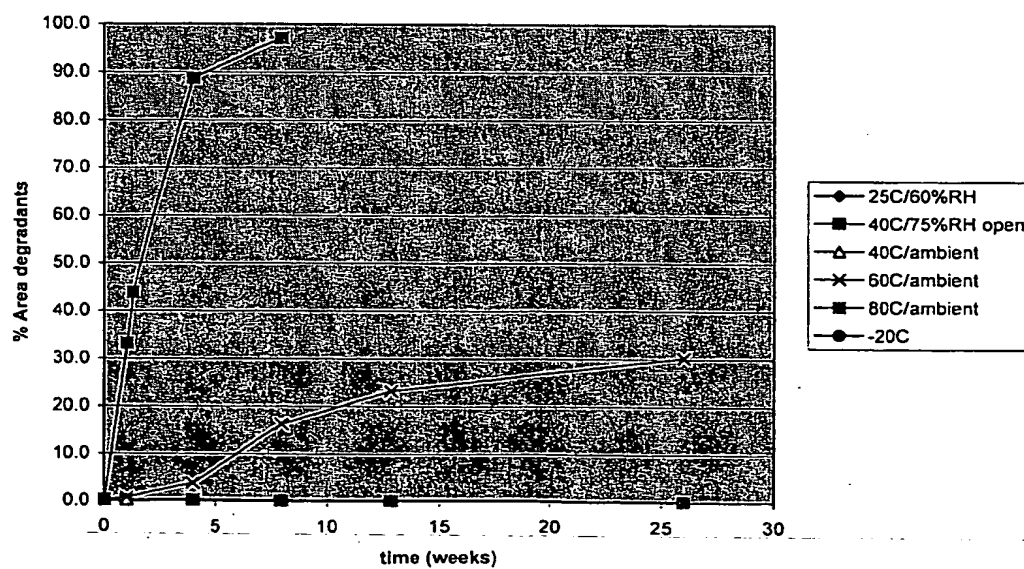


Figure 50

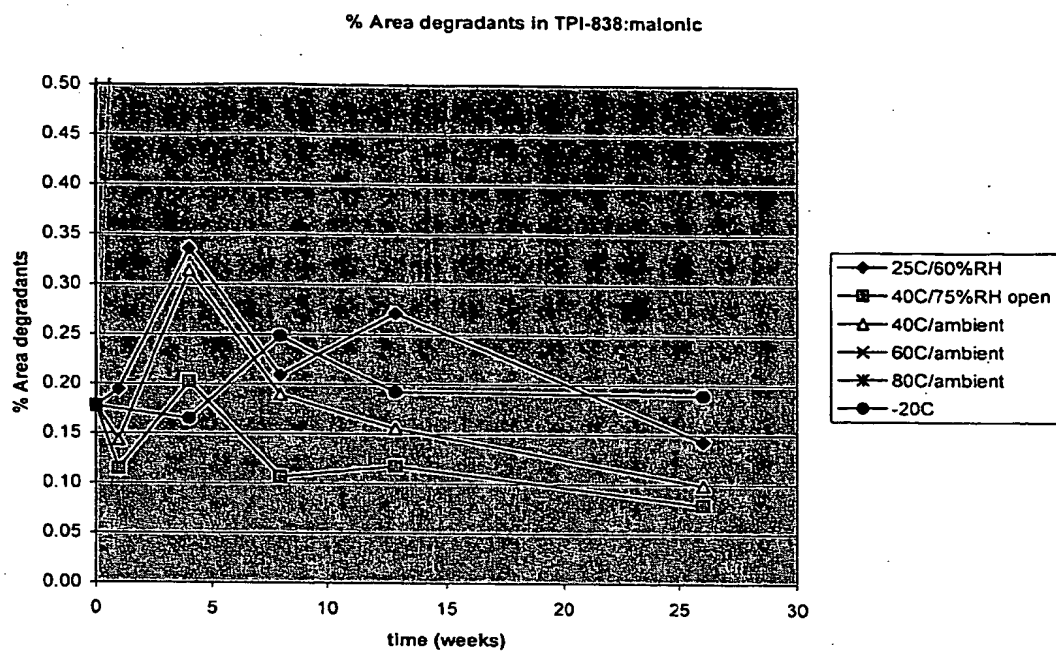


Figure 51

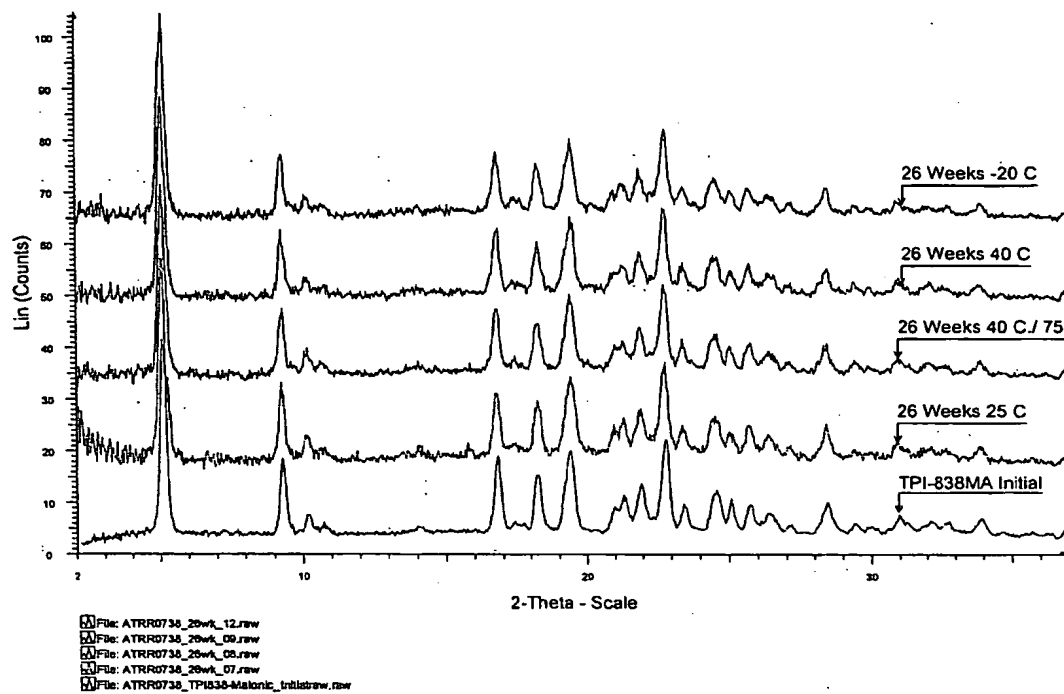


Figure 52



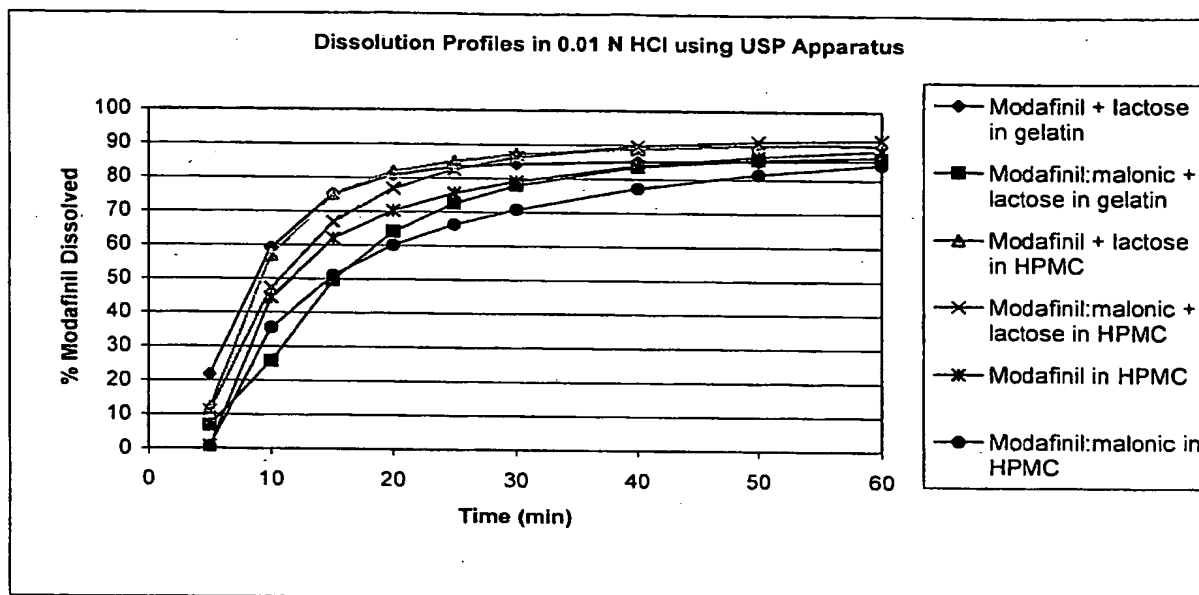


Figure 53

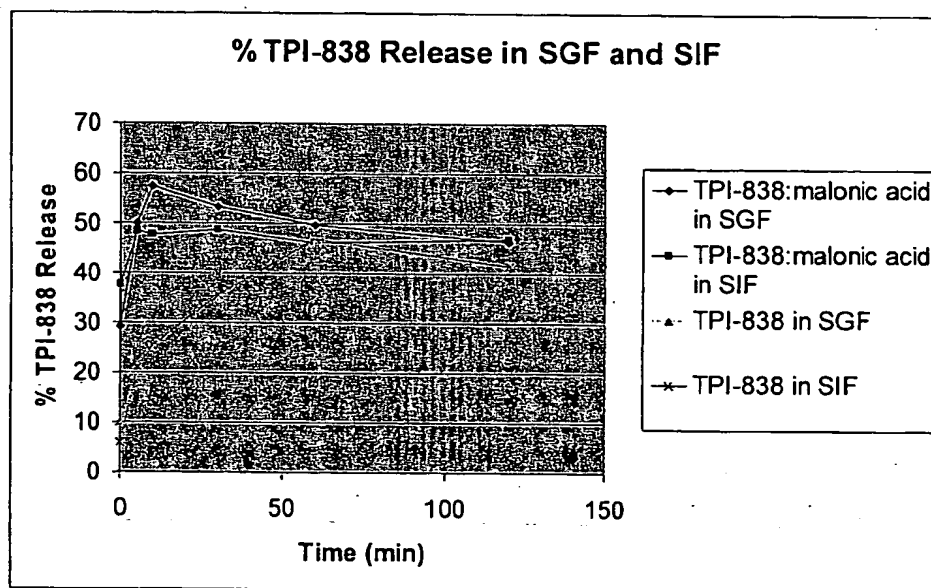


Figure 54

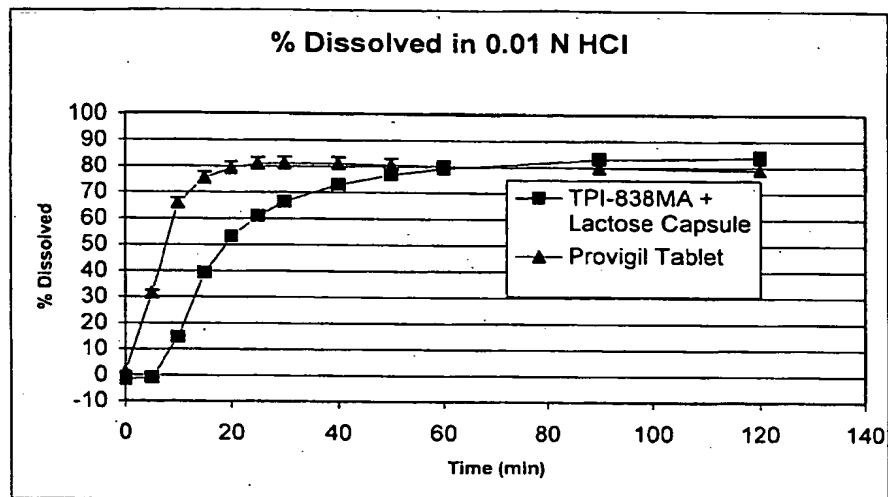


Figure 55

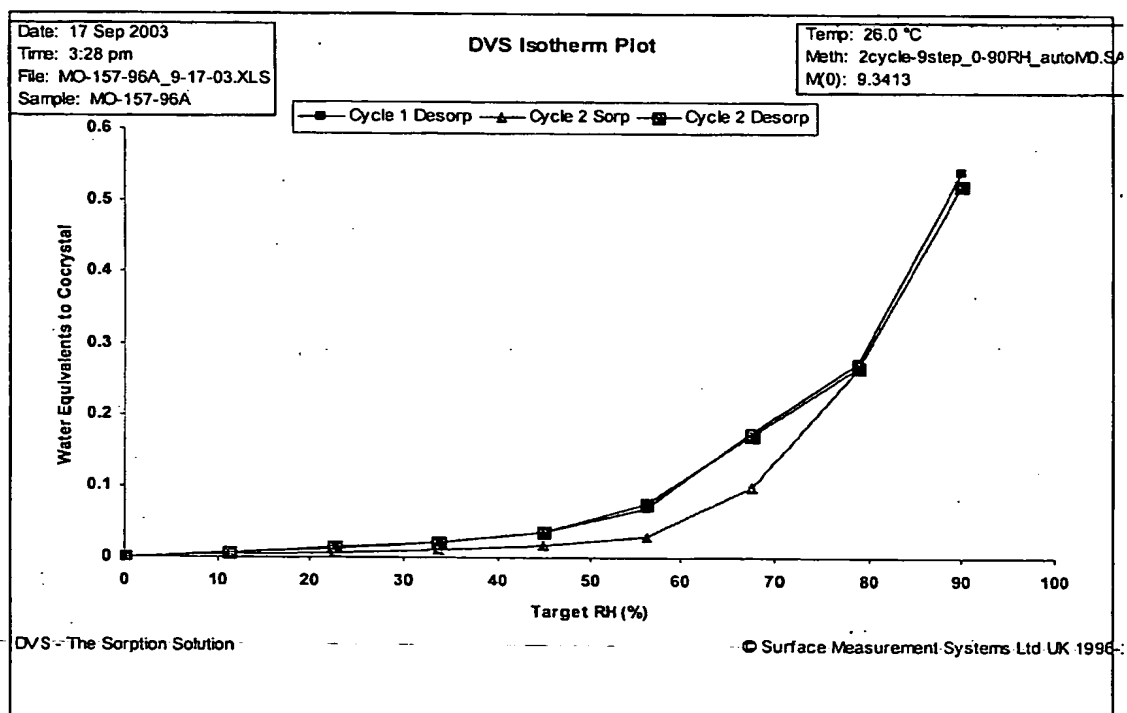


Figure 56

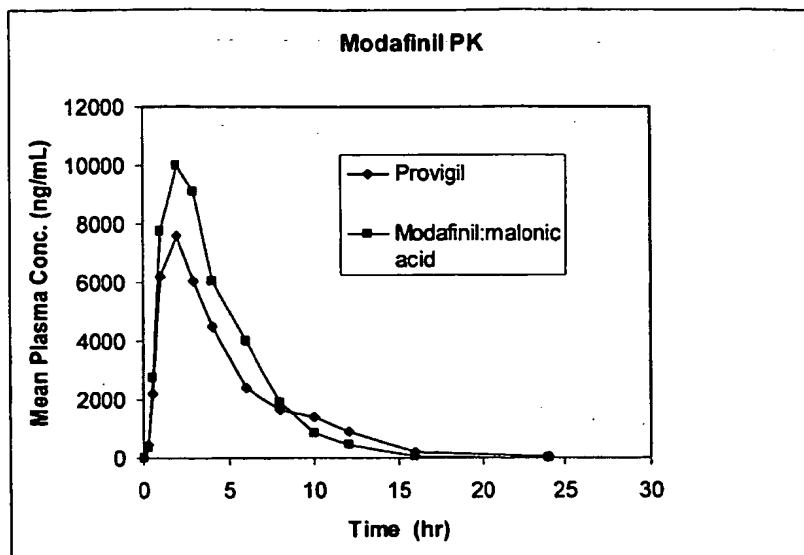


Figure 57

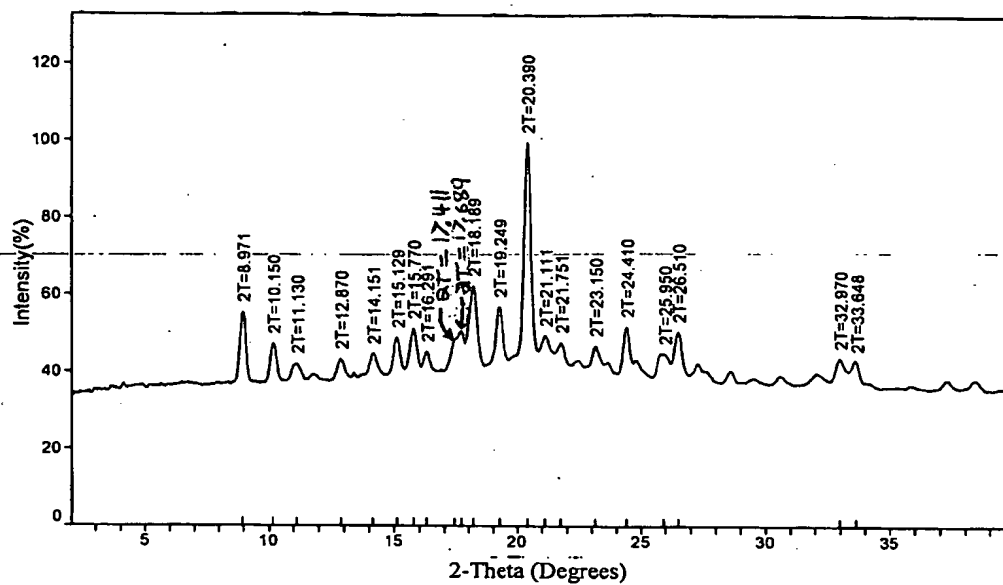


Figure 58A

DSC

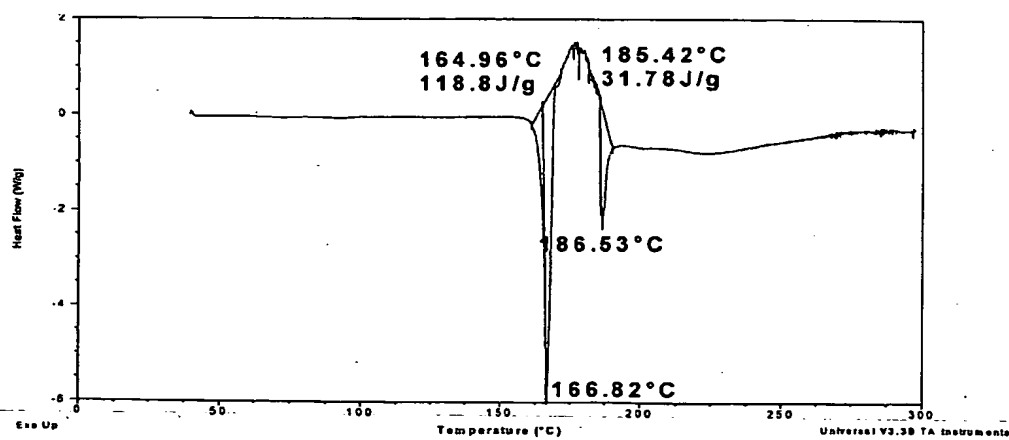


Figure 58B

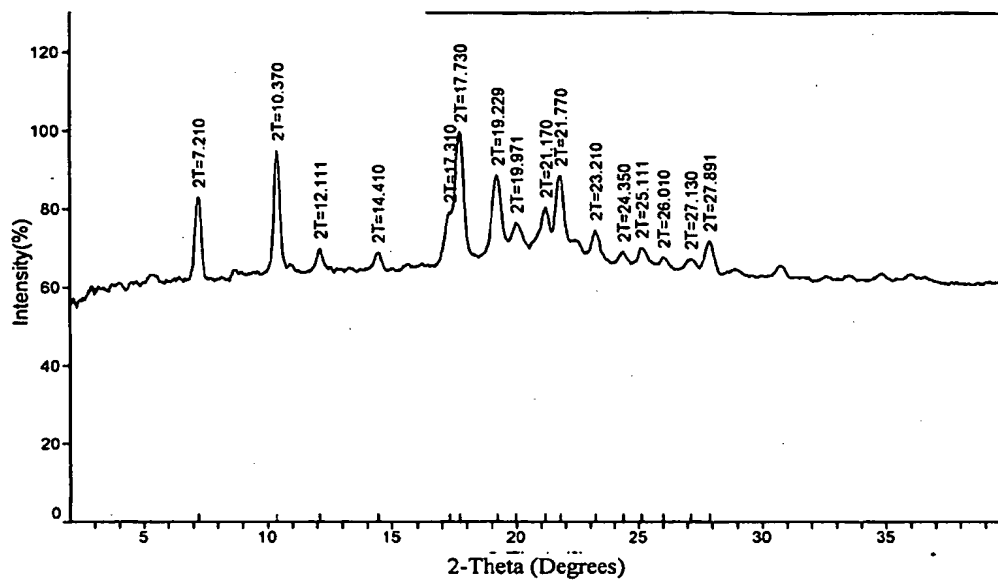


Figure 59A

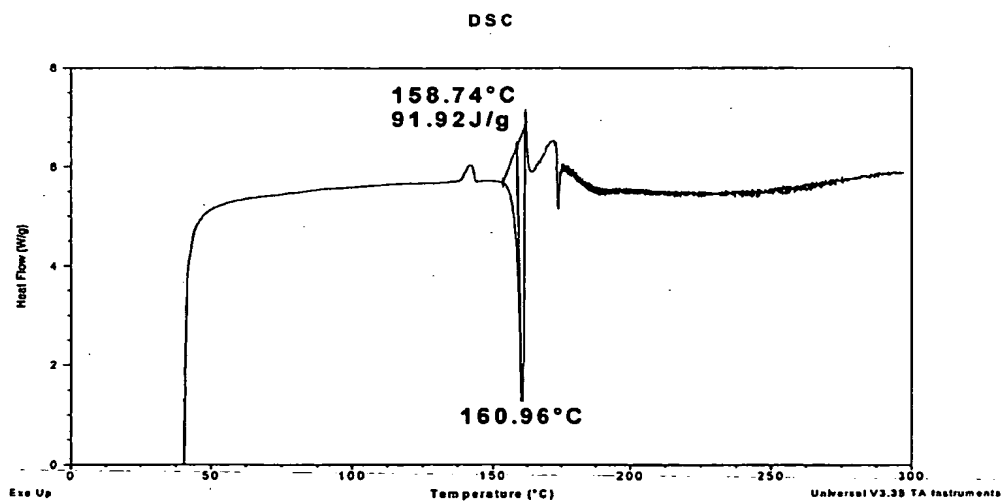


Figure 59B

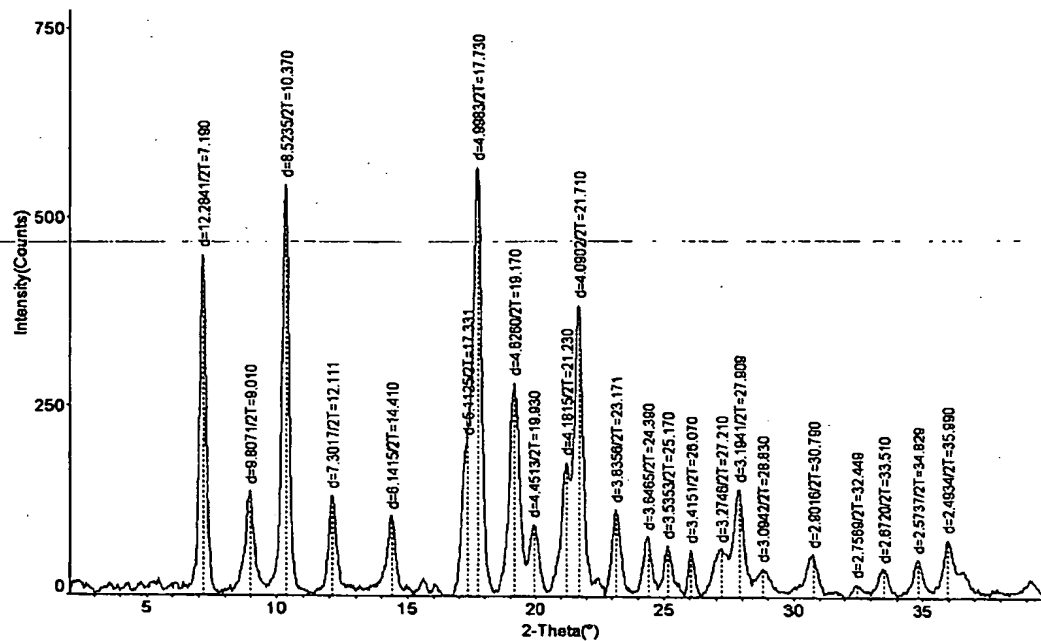


Figure 59C

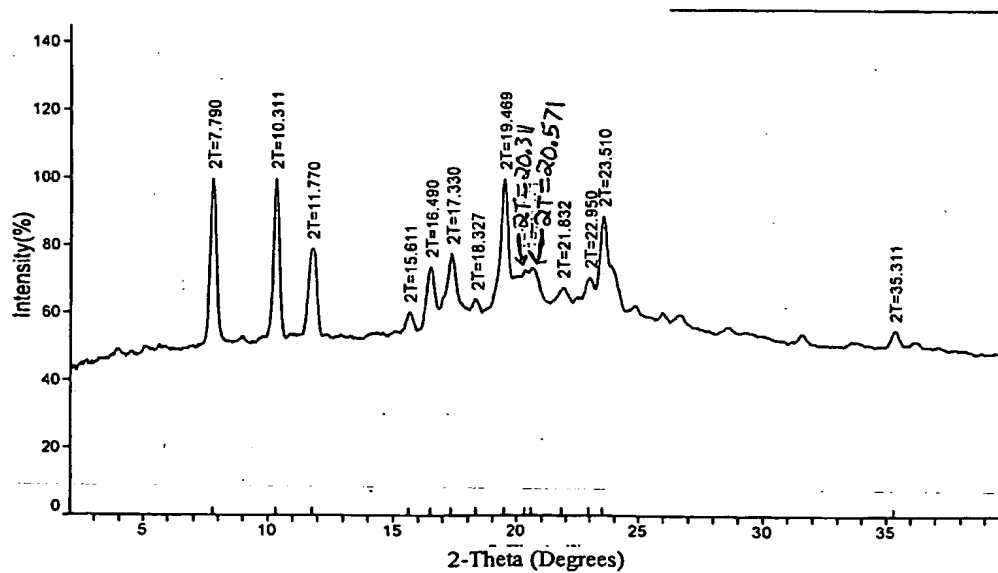


Figure 60A

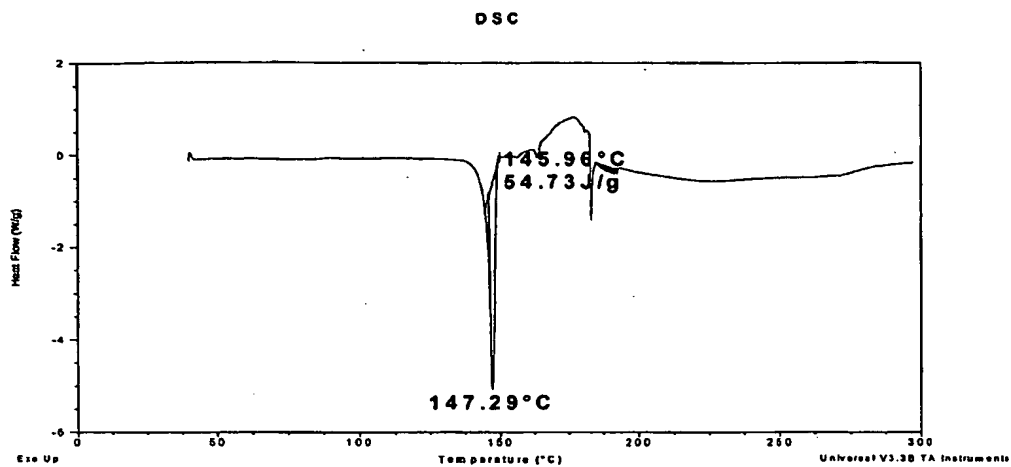


Figure 60B

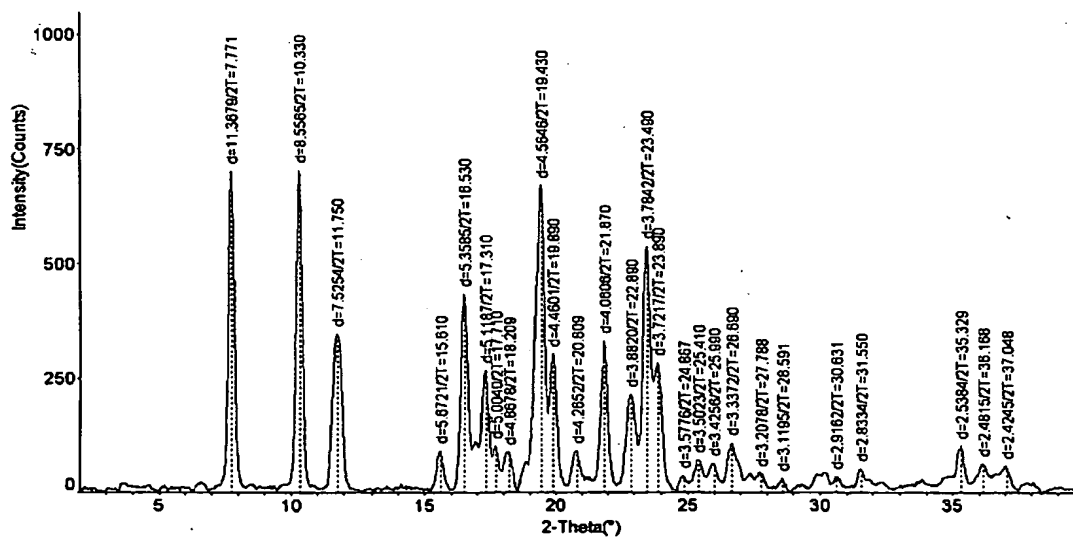


Figure 60C

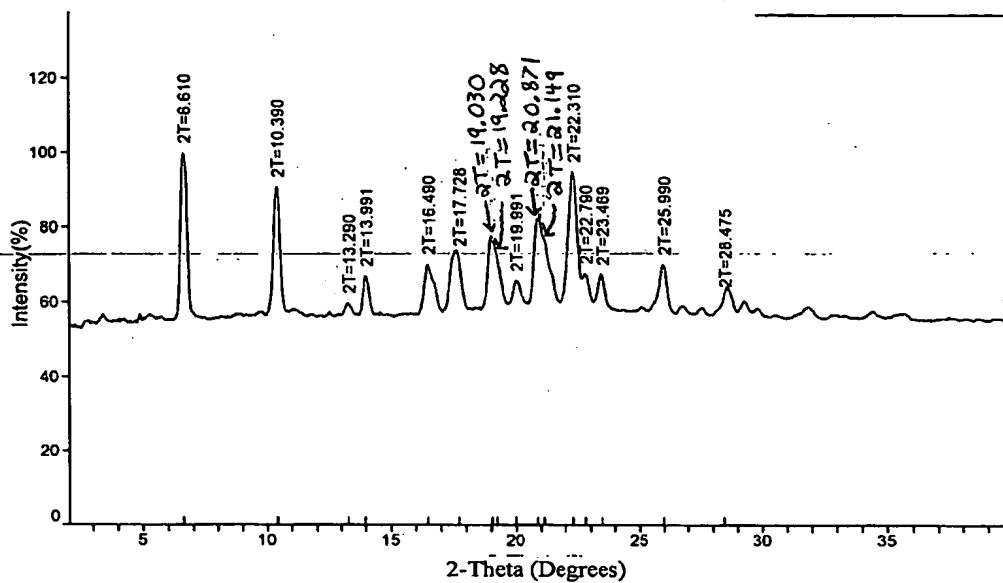


Figure 61A

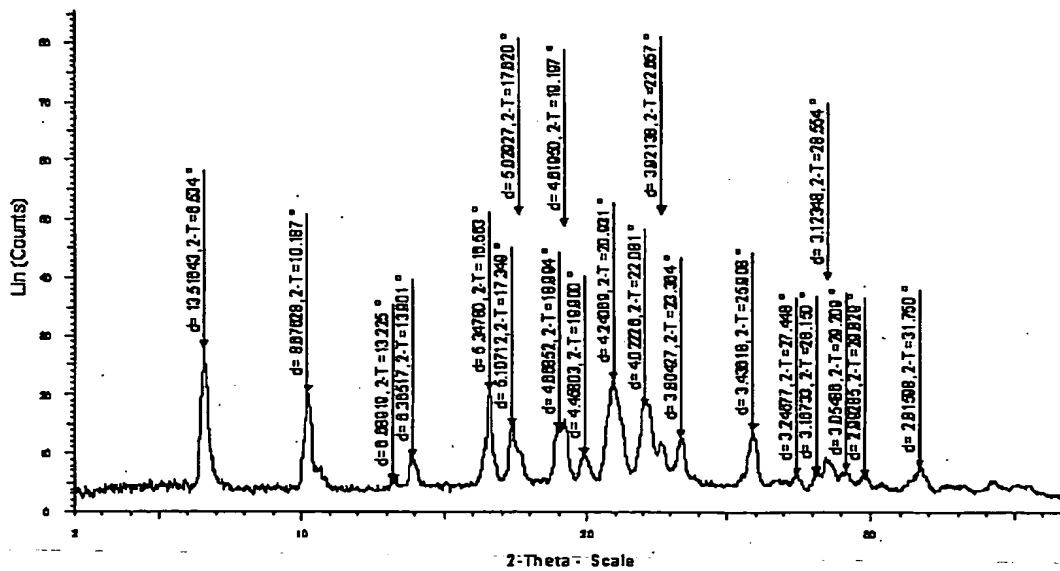


Figure 61B



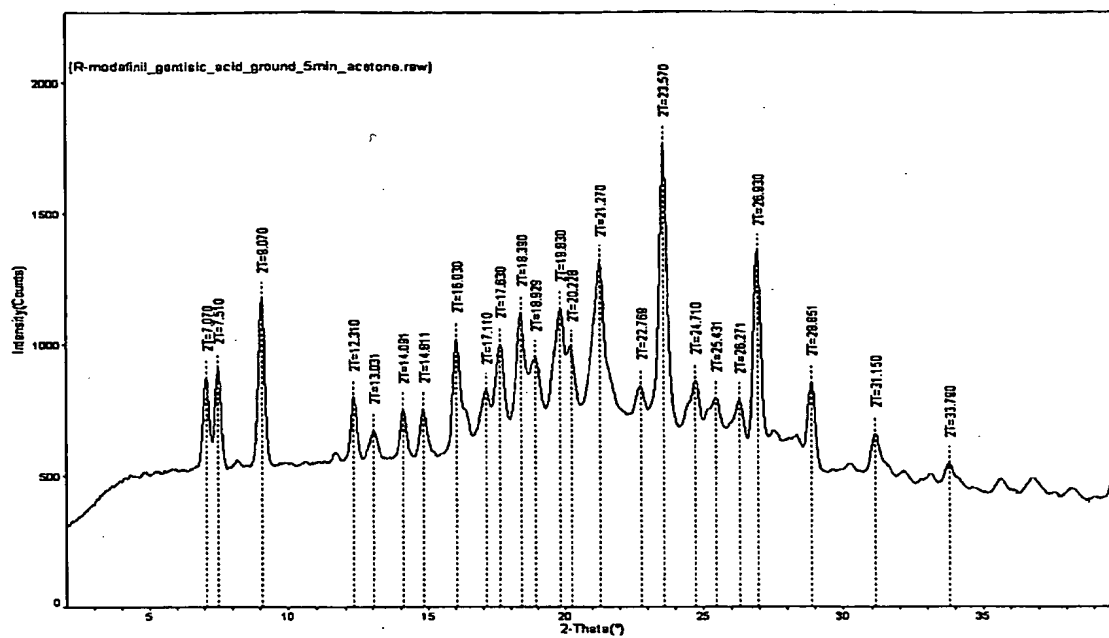


Figure 62

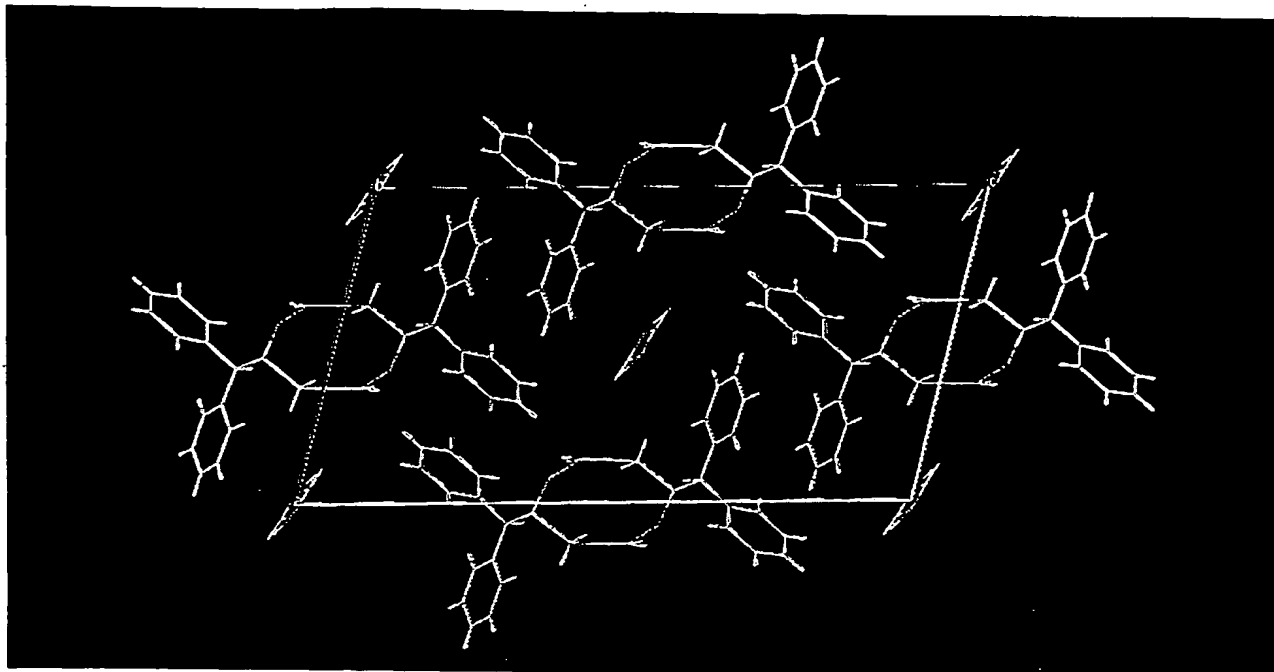


Figure 63

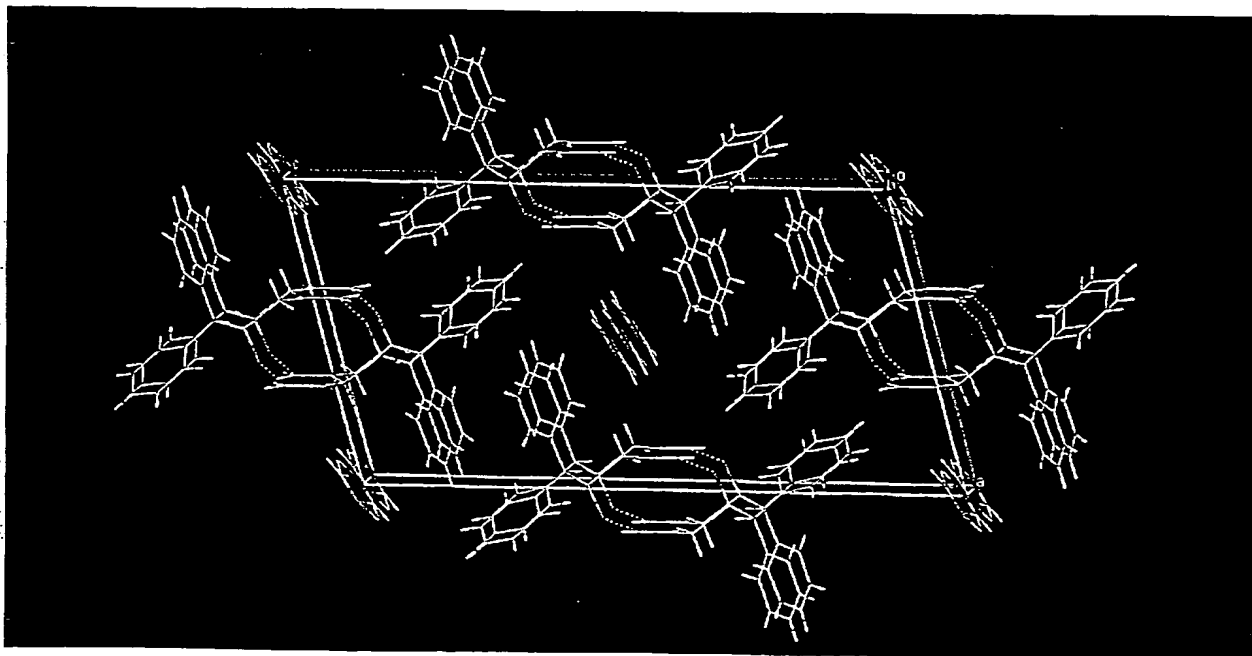


Figure 64

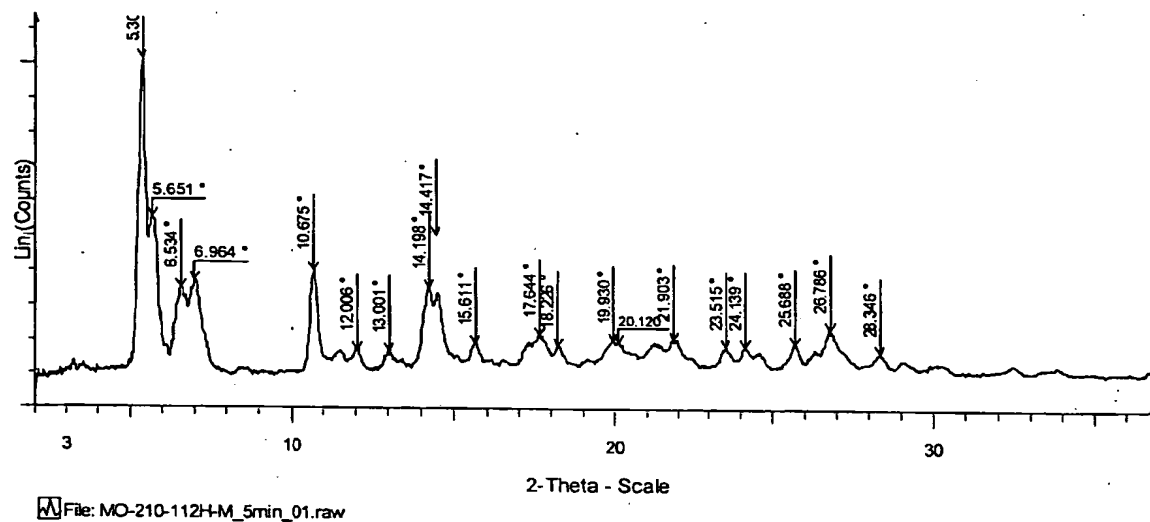


Figure 65

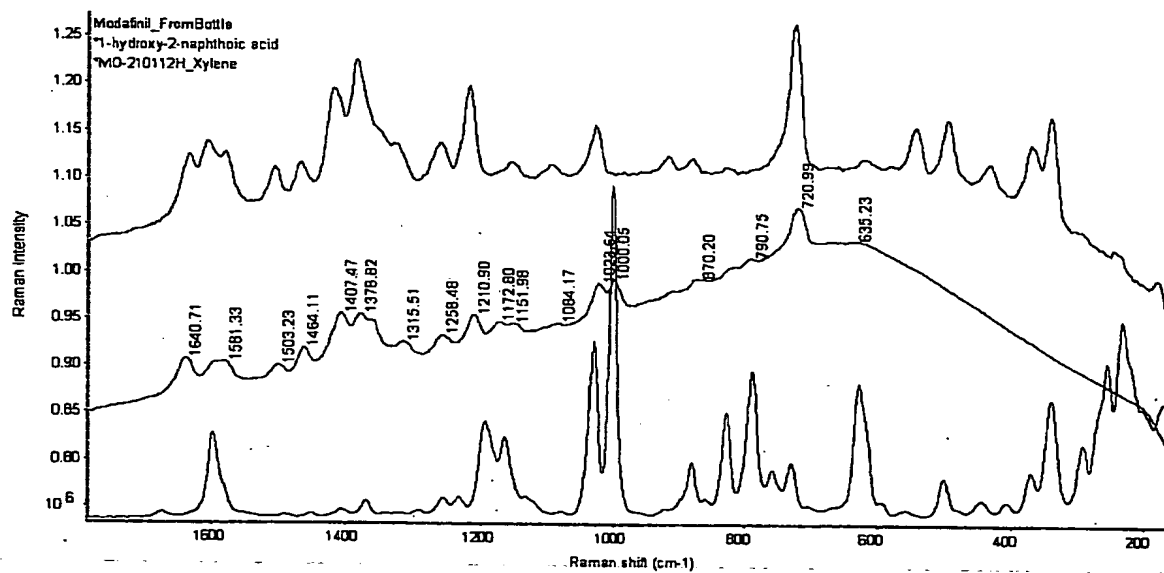


Figure 66

Sample: MO-210-112H\_838Naphth\_Xylene  
Size: 5.2030 mg

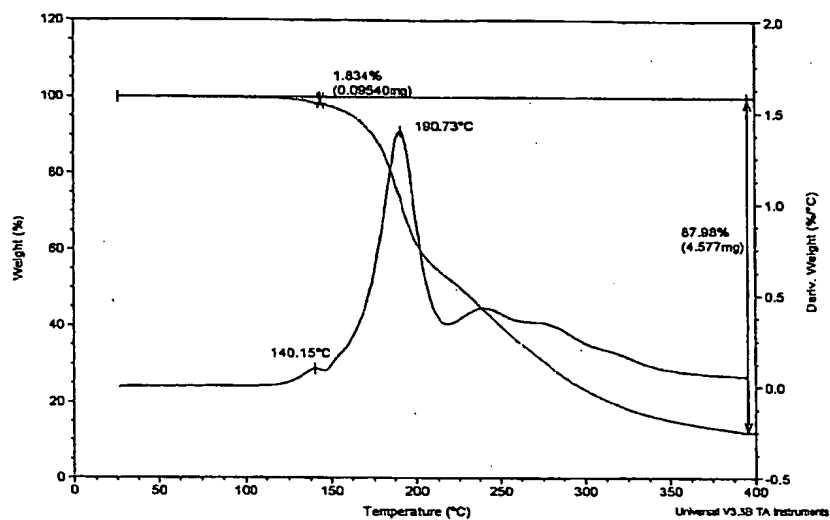


Figure 67

Sample: MO-210-112H\_838Naphth\_oXylene  
Size: 2.1150 mg

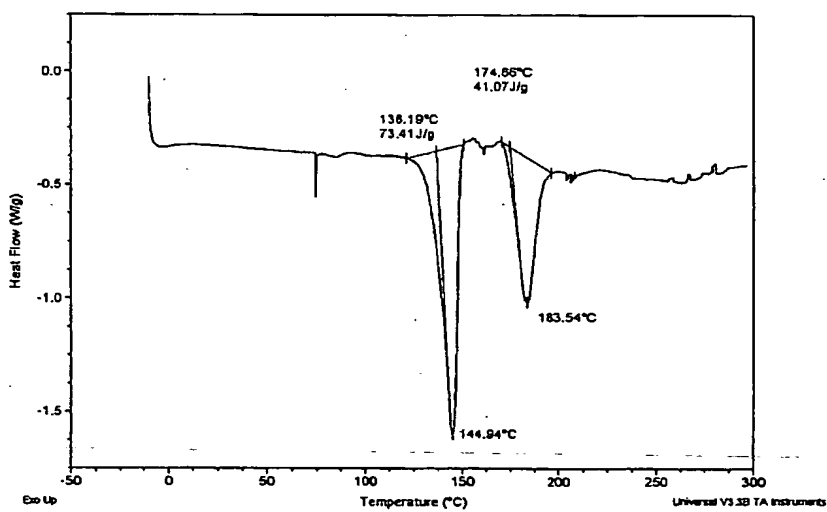


Figure 68

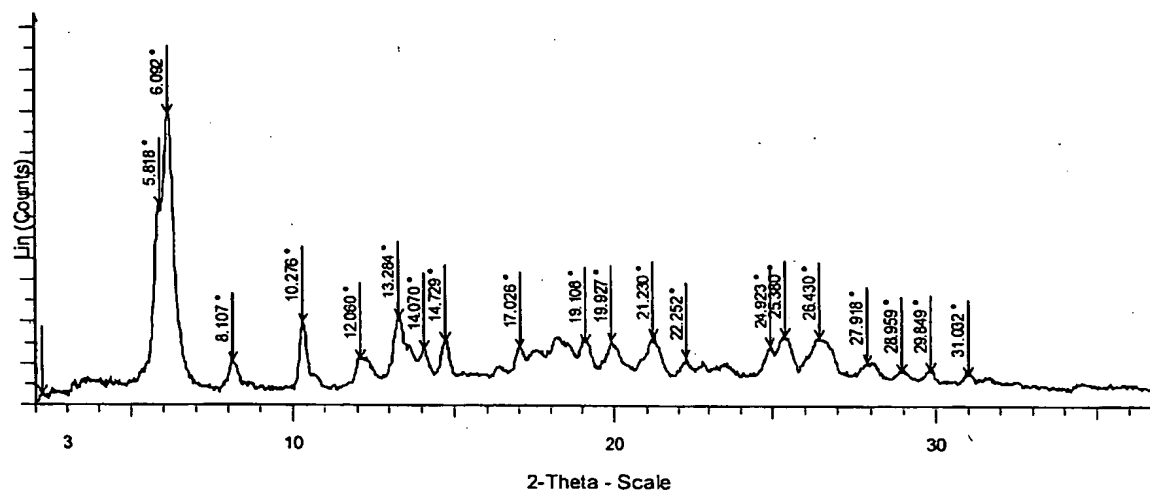


Figure 69

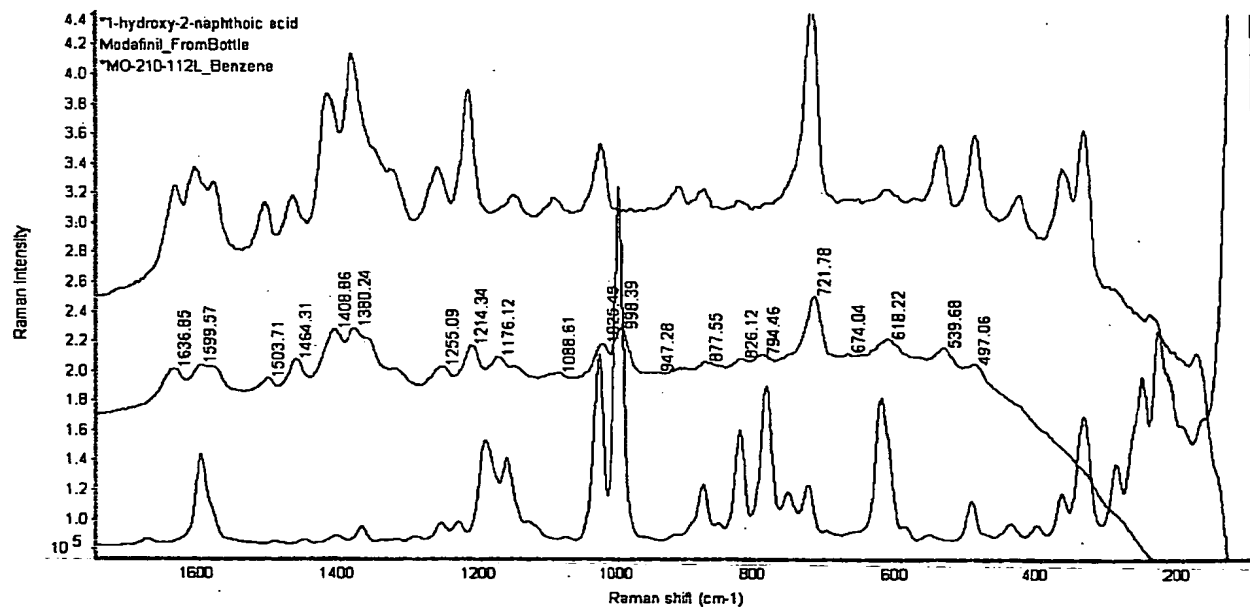


Figure 70

Sample: MO-210-112L\_838Naphth\_Benzene  
Size: 7.0580 mg

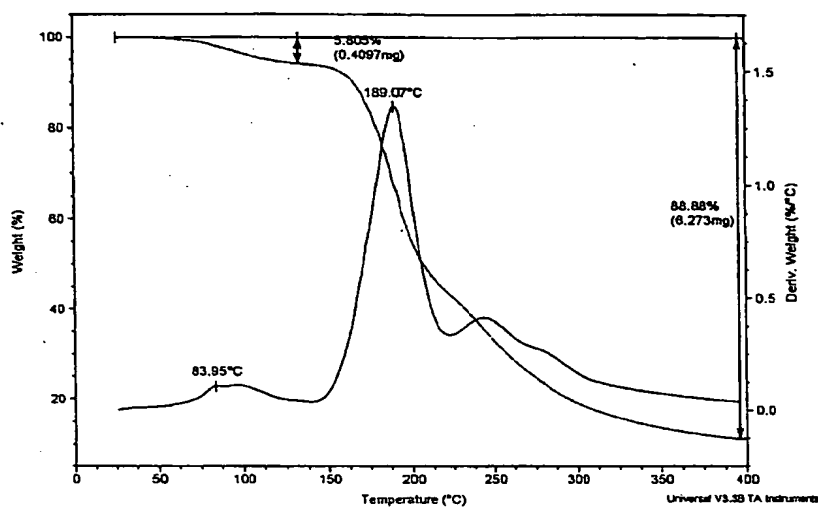


Figure 71

Sample: MO-210-112L\_838Naphth\_Benzene  
Size: 2.1270 mg

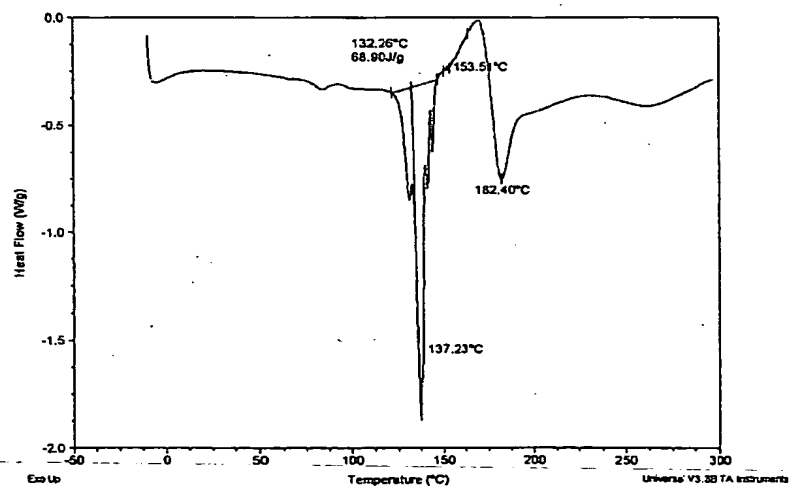


Figure 72

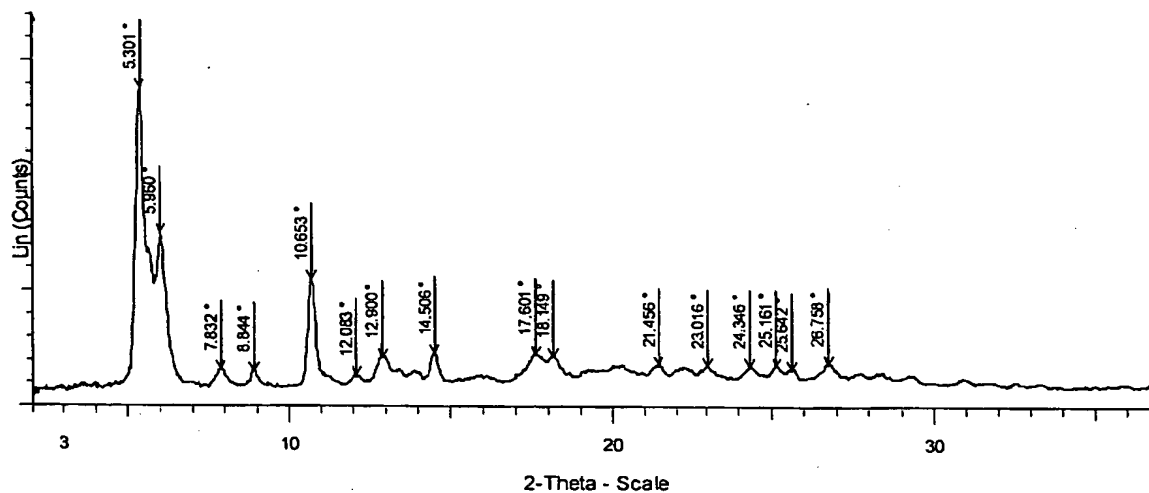


Figure 73

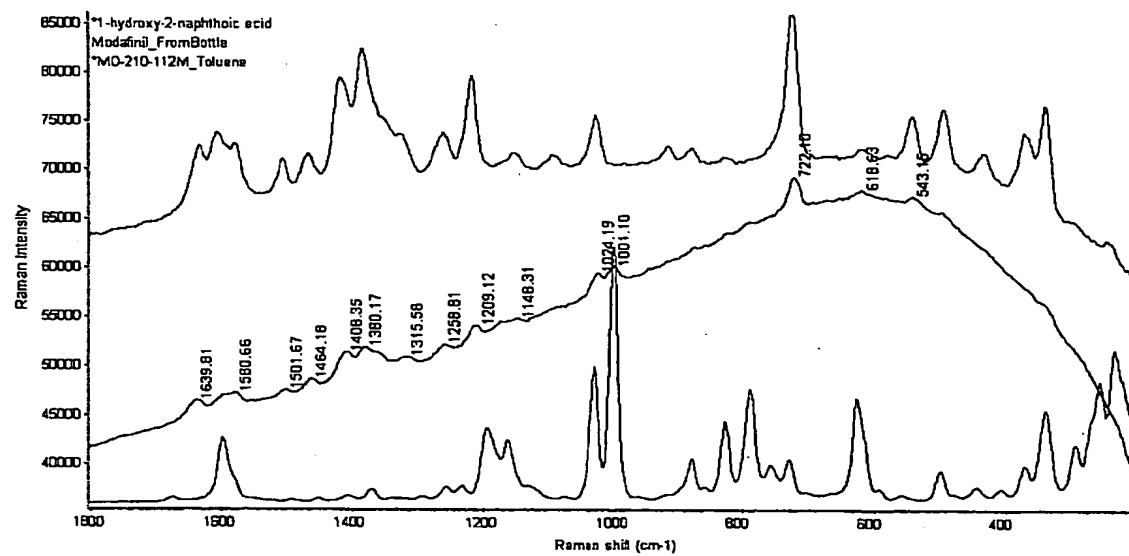


Figure 74

Sample: MO-210-112M\_838Naphth\_Toluene  
Size: 4.1650 mg

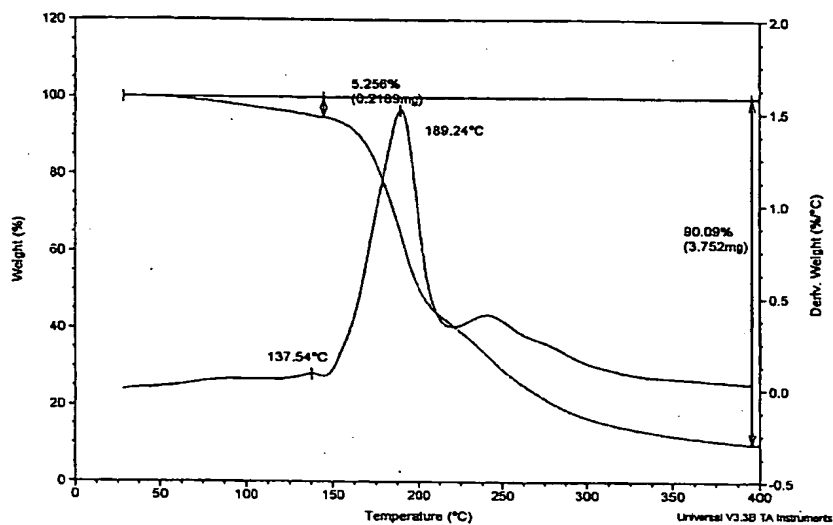


Figure 75

Sample: MO-210-112M\_838Naphth\_Toluene  
Size: 1.2120 mg

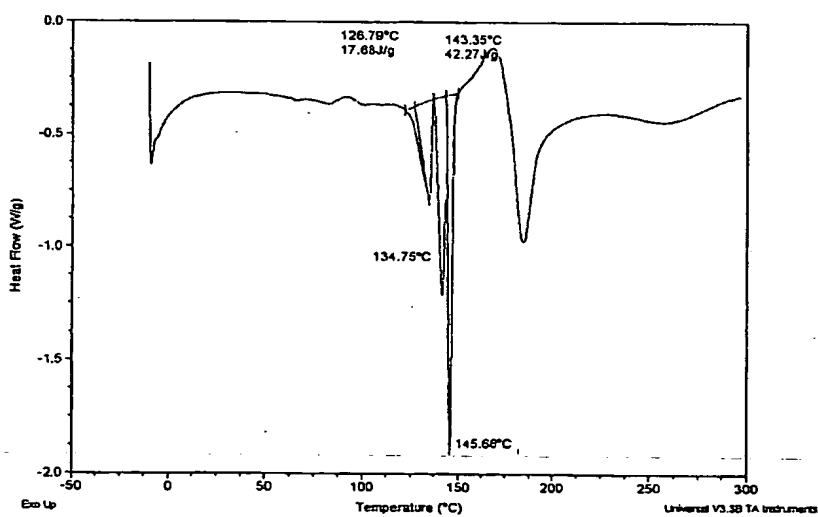


Figure 76



## TABLE I

[illegible]

TABLE I

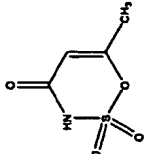
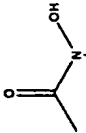
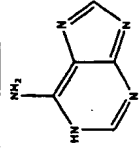
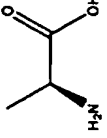
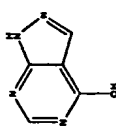
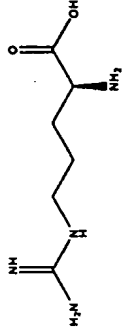
Co-Crystal Former	MW (g/mol)	MP (°C)	Class	Functionality	# acceptors	# donors	Molecular Structure	pKa Values
Acesulfame	163.15	123-124	3	SO <sub>2</sub> , Amide	4	1		-5-7
Acetohydroxamic acid	75.07	89-92	3	Amide, NH, OH	2	2		8.7
Adenine	135.13	220 (sub.)	1	Amine, NH	3	3		3.8
Adipic Acid	146.14	152	1	Carboxylic acid	2	2	HOOC(CH <sub>2</sub> ) <sub>4</sub> COOH	4.44, 5.44
Alanine	89.09	289-291	1	Amine, carboxillic acid	1	3		2.35, 9.87
Allopurinaol	136.11	> 350	3	OH, NH	4	2		10.2
Arginine	174.2	244 (dec.)	1	Amine, COOH	2	7		2.18, 9.09, 13.2

TABLE I

Co-Crystal Former	MW (g/mol)	MP (°C)	Class	Functionality	# acceptors	# donors	Molecular Structure	pKa Values
Ascorbic acid	176.12	190-192	1	C=O, OH	6	4		4.17, 11.57
Asparagine	132.12	234-235	1	Amine, amide, COOH	3	5		2.02, 8.5
Aspartic acid	133.1	270-271	1	Amine, COOH	2	4		1.88, 3.65, 9.60
Benzenesulfonic Acid	158.18	43-44	1	SO <sub>3</sub> H	2	1		0.70, 1.58
Benzoic acid*	122.12	122-123	2	COOH	1	1		4.19
Caffeine	194.19	238	3	C=O	3	0		
Camphoric acid	200.23	186-189	2	Carboxylic acid	2	2		4.72, 5.83

TABLE I

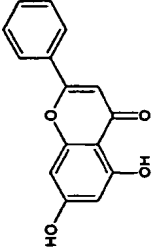
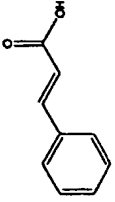
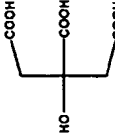
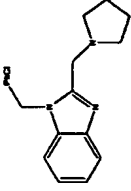
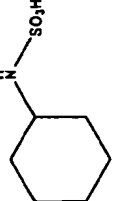
Co-Crystal Former	MW (g/mol)	MP (°C)	Class	Functionality	# acceptors	# donors	Molecular Structure	pKa Values
Capric acid	172.27	31.4	1	Carboxylic acid	1	1	<chem>CH3(CH2)8COOH</chem>	4.9
Chrysin	254.24	285	1	Phenol, ether, ketone	2	2		
Cinnamic acid	144.2	133	3	Carboxylic acid	1	1		4.4
Citric Acid	192.12	153	1	OH, COOH	4	4		3.13, 4.76, 6.40
Clemizole	325.84	167	1	Pyrrolidine	3	0		
Cyclamic acid	179.24	169-170	3	NH, SO <sub>3</sub> H	2	2		-2

TABLE I

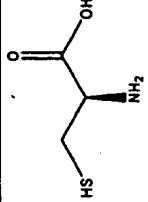
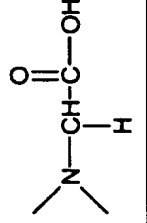
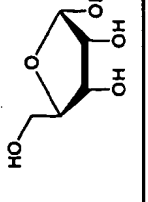
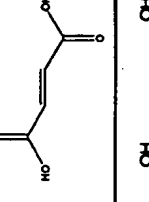
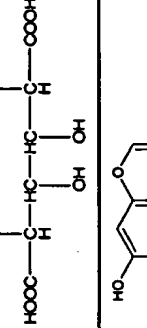
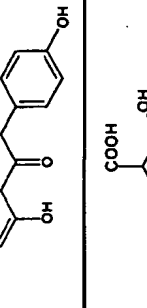
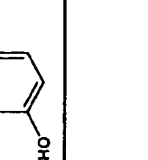
Co-Crystal Former	MW (g/mol)	MP (°C)	Class	Functionality	# acceptors	# donors	Molecular Structure	pKa Values
Cysteine	121.15	---	1	Amine, COOH, SH	2	4		1.71, 8.33, 10.78
Dimethylglycine	103.1	178-192	1	Amine, Carboxylic acid	2	1		2.5
D-Ribose	150.13	87	1	Alcohol, ether	1	4		
Fumaric acid	116.07	287	1	COOH	2	2		3.03, 4.38
Galactaric acid	210.14	255 (dec)	1	Carboxylic acid, alcohol	2	6		3.08, 3.63
Genistein	270.24	297-298	1	Alcohol, Phenol, ether, ketone	2	3		
Gentisic acid	154.12	199-200 form I, 205 form II	2	Carboxylic acid, alcohol, phenol	1	3		2.93

TABLE I

Co-Crystal Former	MW (g/mol)	MP (°C)	Class	Functionality	# acceptors	# donors	Molecular Structure	pKa Values
Glucamine, N-Methyl	195.22	128-129	1	Alcohol, Amine	5	6		8.03(B)
Gluconic acid	196.15	131	1	OH, COOH	6	6		3.76
Glucosamine	179.17	88	1	OH	5	6		6.91
Glucuronic acid	194.14	165	1	Carboxylic acid, alcohol, aldehyde	2	5		3.18
Glutamic acid	147.13	160	1	Amine, COOH	2	4		2.19, 4.25, 9.67
Glutamine	146.15	185-186	1	Amine, Amide, COOH	2	5		2.17, 9.13
Glutaric acid	132.11	98-98	1	COOH	2	2		2.7, 4.5

TABLE I

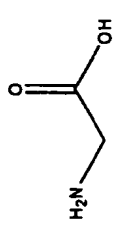
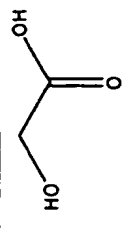
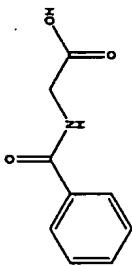
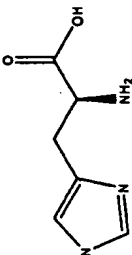
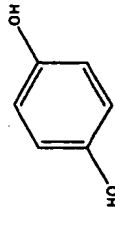
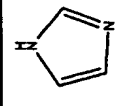
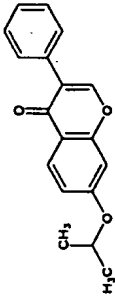
Co-Crystal Former	MW (g/mol)	MP (°C)	Class	Functionality	# acceptors	# donors	Molecular Structure	pKa Values
Glycine	75.07	182	1	Amine, COOH	2	3		2.34, 9.6
Glycolic acid	76.05	80	1	OH, COOH	2	2		3.82
Hippuric acid	179.17	187-188	1	Amide, NH, COOH	2	2		3.55
Histidine	155.16	287 (dec.)	1	Amine, COOH, Imidazole	2	4		1.78, 5.97, 8.97
Hydroquinone*	110.11	170-171	2	OH, Phenol	2	2		~10
Imidazole	68.08	90-91	1	NH	1	1		6.92
Ipriflavone	280.32	115-117	1	Ketone, ether	3	0		

TABLE I

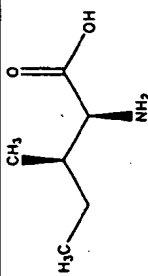
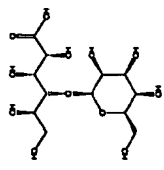
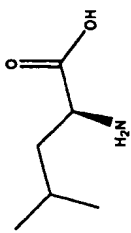
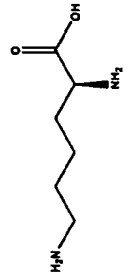

Co-Crystal Former	MW (g/mol)	MP (°C)	Class	Functionality	# acceptors	# donors	Molecular Structure	pKa Values
Isoleucine	131.17	168-170 (sub.)	1	Amine, COOH	1	3		2.32, 9.76
Lactobionic acid	358.3	128-130	2	Alcohol, carboxylic acid, ether	1	9		3.2
Lauric acid	200.32	44-48	1	Carboxylic acid	1	1	$\text{CH}_3(\text{CH}_2)_{10}\text{COOH}$	~4.5
Leucine	131.17	145-148 (sub.)	1	Carboxylic acid, amine	1	3		2.36, 9.6
Lysine	146.19	225 (dec.)	1	Amine, COOH	1	5		2.2, 8.9, 10.28
Maleic	116.07	138-139	1	COOH	2	2		1.92, 6.23



TABLE I

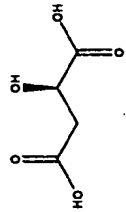
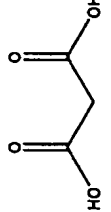
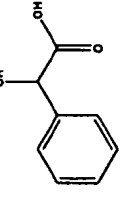
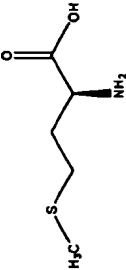
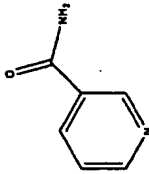
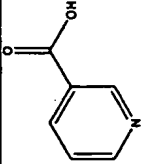
Co-Crystal Former	MW (g/mol)	MP (°C)	Class	Functionality	# acceptors	# donors	Molecular Structure	pKa Values
Malic acid	134.09	131-132	1	OH, COOH	3	3		3.46, 5.1
Malonic	104.06	135	1	COOH	2	2		2.83, 5.70
Mandelic acid	152.15	119	1	OH, COOH	2	2		3.37
Methionine	149.21	280-282 (dec.)	1	Amine, COOH, S- Me	2	3		2-3, 9
Nicotinamide	122.12	128-131	1	Pyridine, amide	2	2		3.3
Nicotinic acid	123.11	236-237	2	Carboxylic acid, pyridine	2	1		2.07(B), 4.85

TABLE I

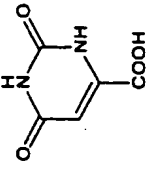
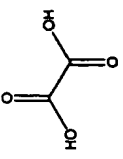
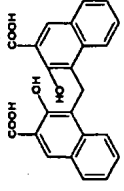
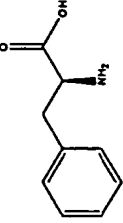
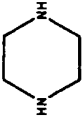
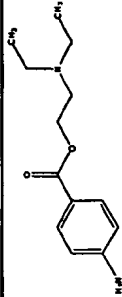
Co-Crystal Former	MW (g/mol)	MP (°C)	Class	Functionality	# acceptors	# donors	Molecular Structure	pKa Values
Orotic acid	156.1	345-346	2	Carboxylic acid, lactam	3	3		5.85, 8.95
Oxalic acid	90.04	189 (dec)	2	Carboxylic acid	2	2		1.27, 4.27
Palmitic acid	256.43	63-64	1	Carboxylic acid	1	1	$\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$	4.9
Pamoic	388.38	280 (dec)	2	Carboxylic acid, phenol	2	4		2.51, 3.1
Phenylalanine	165.19	283 (dec.)	1	Amine, COOH	1	3		~2, ~9
Piperazine	86.14	106	1	NH	0	2		9.82(B)
Procaine	236.31	61	1	Amine, C=O	2	2		8.9(B)

TABLE I

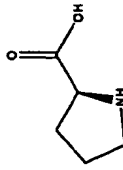
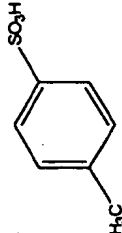
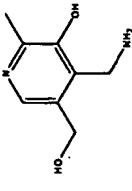
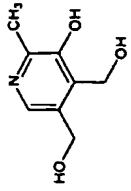
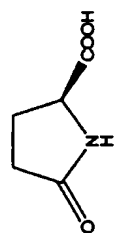
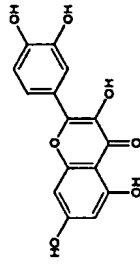
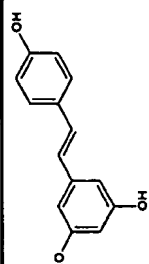
Co-Crystal Former	MW (g/mol)	MP (°C)	Class	Functionality	# acceptors	# donors	Molecular Structure	pKa Values
Proline	115.13	220-222 (dec.)	1	COOH, NH	1	2		1.99, 10.6
p-Toluenesulfonic acid	172.2	106-107	2	Sulfonic acid	2	1		-1.34
Pyridoxamine	168	193-194	2	OH, Amine, Pyridine	3	4		~9
Pyridoxine	170	160	2	Alcohol, Pyridine	3	3		~9
Pyroglutamic acid	129.12	162	2	Carboxylic acid, Lactam	2	2		3.32
Quercetin	302.24	314 dec.	1	Phenol, ether, ketone	2	5		
Resveratrol	228.24	253-255	1	Phenol	0	3		

TABLE I

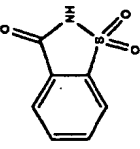
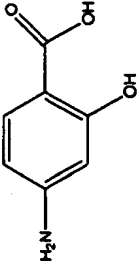
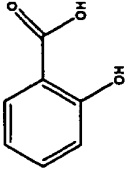
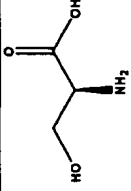
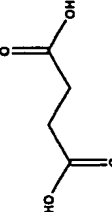
Co-Crystal Former	MW (g/mol)	MP (°C)	Class	Functionality	# acceptors	# donors	Molecular Structure	pKa Values
Saccharin	183.19	228-230	1	Amide, C=O, S=O, N-H	3	1		2
Salicylic acid, 4-amino	153.14	150-151	3	COOH, OH, Aniline	1	4		3.25, 10, 3.5(B)
Salicylic acid	138.12	159	3	COOH, OH	2	2		2.98, 13.82
Sebacic acid	202.25	134.5	1	Carboxylic acid	2	2	HOOC(CH <sub>2</sub> ) <sub>8</sub> COOH	4.59, 5.59
Serine	105.09	228 (dec.)	1	Carboxylic acid, amine, OH	2	3		2.21, 9.15
Stearic acid	284.47	70-71	1	Carboxylic acid	1	1	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>16</sub> COOH	4.9
Succinic acid	118.09	185-187	1	Carboxylic acid	2	2		4.21, 5.64

TABLE I

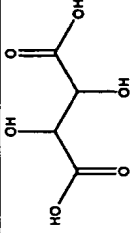
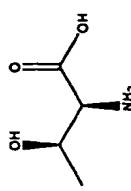
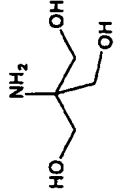
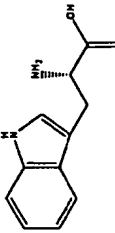
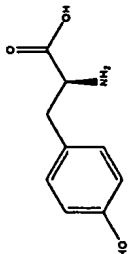
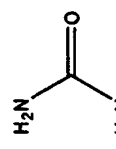
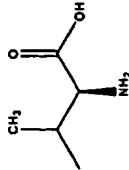
Co-Crystal Former	MW (g/mol)	MP (°C)	Class	Functionality	# acceptors	# donors	Molecular Structure	pKa Values
Tartaric acid	150.09	205-206	1	Carboxylic acid	4	4		3.02, 4.36
Threonine	119.12	255-257 (dec.)	1	Amine, COOH, OH	2	4		2.15, 9.12
TRIS	121.13	171-172	2	Amine, OH	3	5		5.91, 8.3
Tryptophan	204.23	289 (dec.)	1	Amine, COOH, Indole	1	4		2.38, 9.39
Tyrosine	181.19	342-344	1	Amine, COOH, OH	2	3		2.2, 9.11, 10.07
Urea	60.06	Dec.	1	C=O, NH2	1	4		~8
Valine	117.15	315	1	Amine, COOH	1	3		~4.5, ~9

TABLE I

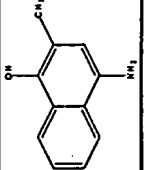
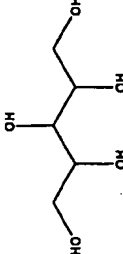
Co-Crystal Former	MW (g/mol)	MP (°C)	Class	Functionality	# acceptors	# donors	Molecular Structure	pKa Values
Vitamin K5	209.68	280-282 (dec.)	3	Amine, OH	1	3		~9
Xylitol	152.15	93-95 (l)	2	OH	5	5		~9

TABLE II

Co-crystal Former	Co-crystal Former Functional Group	Interacting Group							
		pyridine	ketone	aldehyde	ether	ester	amide		
1,5-Naphthalene-disulfonic Acid	Sulfonic Acid								amide
1-Hydroxy-2-naphthoic acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine		aniline
1-Hydroxy-2-naphthoic acid	alcohol	alcohol	ketone	thiol	amide	amine	amine		aniline
4-Aminobenzoic Acid	Amine	alcohol	ketone	thiol	amide	amine	amine		aniline
4-Aminobenzoic Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine		aniline
4-aminopyridine	Amine	alcohol	ketone	thiol	amide	amine	amine		aniline
4-aminopyridine	Pyridine	*alcohol	pyridinium	*	*amide	nitro			*amine
4-Chlorobenzene-Sulfonic Acid	Sulfonic Acid								
4-ethoxyphenyl Urea	Amide	pyridine	ketone	aldehyde	ether	ester	amide		amide
4-ethoxyphenyl Urea	Amine	alcohol	ketone	thiol	amide	amine	amine		aniline
7-oxo-DHEA	alcohol	alcohol	ketone	thiol	amide	amine	amine		aniline
7-oxo-DHEA	Ketone	alcohol		thiol	amide	amine	amine		aniline
Acesulfame	Sulfone	pyridine	ketone		ether				
Acesulfame	Amide	alcohol	ketone	aldehyde	amide	ester	amine		aniline
Acetohydroxamic Acid	Amide	alcohol	ketone	thiol	amide	amine	amine		aniline
Acetohydroxamic Acid	Amine	alcohol	ketone	thiol	amide	amine	amine		aniline
Acetohydroxamic Acid	Alcohol	alcohol	ketone	thiol	amide	amine	amine		aniline
Adenine	Amine	alcohol	ketone	thiol	amide	amine	amine		aniline
Adenine	N	*alcohol	pyridinium	*	*amide	nitro			*amine
Adipic acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine		aniline
Alanine	Amine	alcohol	ketone	thiol	amide	amine	amine		aniline
Alanine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine		aniline
Allopurinol	Alcohol	alcohol	ketone	thiol	amide	amine	amine		aniline
Allopurinol	Amine	alcohol	ketone	thiol	amide	amine	amine		aniline
Arginine	Amine	alcohol	ketone	thiol	amide	amine	amine		aniline
Arginine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine		aniline
Ascorbic Acid	Ketone	alcohol		thiol	amide	amine	amine		aniline
Ascorbic Acid	Alcohol	alcohol	ketone	thiol	amide	amine	amine		aniline
Ascorbic Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine		aniline
Asparagine	Amine	alcohol	ketone	thiol	amide	amine	amine		aniline

TABLE II

Co-crystal Former	Carboxylic Acid	amine	metals	thioether	nitrate	sulfate	alcohol	
1,5-Naphthalene-disulfonic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	alcohol	
1-Hydroxy-2-naphthoic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid	metals
1-Hydroxy-2-naphthoic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid	metals
4-Aminobenzoic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
4-Aminobenzoic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
4-aminopyridine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
4-aminopyridine	*Carboxylic Acid	*sulfonamide	*ketone	ether	triazole		ammonium	oxime
4-Chlorobenzene-Sulfonic Acid	phenol	phosphate	metals	thioether		sulfate	alcohol	
4-ethoxyphenyl Urea	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
4-ethoxyphenyl Urea	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
7-oxo-DHEA	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid	metals
7-oxo-DHEA	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
Acetosulfame	carboxylic acid	amine	metals	thioether		sulfate	alcohol	
Acetosulfame	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
Acetohydroxamic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Acetohydroxamic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Acetohydroxamic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
Adenine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Adenine	*carboxylic acid	*sulfonamide	*ketone	ether	triazole		ammonium	oxime
Adipic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Alanine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Alanine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Allopurinol	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
Allopurinol	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Arginine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Arginine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Ascorbic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
Ascorbic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
Ascorbic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Asparagine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid



Co-crystal Former										
1,5-Naphthalene-disulfonic Acid	aldehyde	ester	ether	cyano						
1-Hydroxy-2-naphthoic acid	aldehyde	ester	ether	cyano			furane	bromine	chlorine	
1-Hydroxy-2-naphthoic acid	aldehyde	ester	ether	cyano			furane	bromine	chlorine	
4-Aminobenzoic Acid	metals	aldehyde	ester	ether				furane	bromine	
4-Aminobenzoic Acid	metals	aldehyde	ester	ether				furane	bromine	
4-aminopyridine	metals	aldehyde	ester	ether				furane	bromine	
4-aminopyridine	*chlorine		thiol	n-heterocyclic ring			thionedisulfide	pyrrolidindione	iodine	hydrazone
4-Chlorobenzene-Sulfonic Acid										
4-ethoxyphenyl Urea	metals	aldehyde	ester	ether			cyano	furane	bromine	
4-ethoxyphenyl Urea	metals	aldehyde	ester	ether			cyano	furane	bromine	
7-oxo-DHEA	aldehyde	ester	ether	cyano				furane	bromine	chlorine
7-oxo-DHEA	metals	aldehyde	ester	ether			cyano	furane	bromine	
Acetulfame										
Acetulfame	metals	aldehyde	ester	ether			cyano	furane	bromine	
Acetohydroxamic Acid	metals	aldehyde	ester	ether			cyano	furane	bromine	
Acetohydroxamic Acid	metals	aldehyde	ester	ether			cyano	furane	bromine	
Acetohydroxamic Acid	metals	aldehyde	ester	ether			cyano	furane	bromine	
Adenine	metals	aldehyde	ester	ether			cyano	furane	bromine	
Adenine	*chlorine		thiol	n-heterocyclic ring			thionedisulfide	pyrrolidindione	iodine	hydrazone
Adipic acid	metals	aldehyde	ester	ether			cyano	furane	bromine	
Alanine	metals	aldehyde	ester	ether			cyano	furane	bromine	
Alanine	metals	aldehyde	ester	ether			cyano	furane	bromine	
Allopurinaol	metals	aldehyde	ester	ether			cyano	furane	bromine	
Allopurinaol	metals	aldehyde	ester	ether			cyano	furane	bromine	
Arginine	metals	aldehyde	ester	ether			cyano	furane	bromine	
Arginine	metals	aldehyde	ester	ether			cyano	furane	bromine	
Ascorbic Acid	metals	aldehyde	ester	ether			cyano	furane	bromine	
Ascorbic Acid	metals	aldehyde	ester	ether			cyano	furane	bromine	
Ascorbic Acid	metals	aldehyde	ester	ether			cyano	furane	bromine	
Asparagine	metals	aldehyde	ester	ether			cyano	furane	bromine	

## TABLE II

[illegible]

## TABLE II

[illegible]

TABLE II

Co-crystal Former					
1,5-Naphthalene-disulfonic Acid					
1-Hydroxy-2-naphthoic acid					
1-Hydroxy-2-naphthoic acid					
4-Aminobenzoic Acid	N-SO2	thiourea	iodine		
4-Aminobenzoic Acid	N-SO2	thiourea	iodine		
4-aminopyridine	N-SO2	thiourea	iodine		
4-aminopyridine	dithiadiazocyclopentadienyl				
4-Chlorobenzene-Sulfonic Acid					
4-ethoxyphenyl Urea	N-SO2	thiourea	iodine	epoxide	peroxide
4-ethoxyphenyl Urea	N-SO2	thiourea	iodine		
7-oxo-DHEA					
7-oxo-DHEA	N-SO2	thiourea	iodine		
Acesulfame					
Acesulfame	N-SO2	thiourea	iodine	epoxide	peroxide
Acetohydroxamic Acid	N-SO2	thiourea	iodine	epoxide	peroxide
Acetohydroxamic Acid	N-SO2	thiourea	iodine		
Acetohydroxamic Acid	N-SO2	thiourea	iodine	epoxide	
Adenine	N-SO2	thiourea	iodine		
Adenine	dithiadiazocyclopentadienyl				
Adipic acid	N-SO2	thiourea	iodine		
Alanine	N-SO2	thiourea	iodine		
Alanine	N-SO2	thiourea	iodine		
Allopurinol	N-SO2	thiourea	iodine	epoxide	
Allopurinol	N-SO2	thiourea	iodine		
Arginine	N-SO2	thiourea	iodine		
Arginine	N-SO2	thiourea	iodine		
Ascorbic Acid	N-SO2	thiourea	iodine		
Ascorbic Acid	N-SO2	thiourea	iodine	epoxide	
Ascorbic Acid	N-SO2	thiourea	iodine		
Asparagine	N-SO2	thiourea	iodine		

TABLE II

Co-crystal Former		Interacting Group						
Co-crystal Former	Functional Group	alcohol	ketone	thiol	amide	amine	aniline	
Asparagine	Amide	alcohol	ketone	thiol	amide	amine	aniline	
Asparagine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	
Aspartic Acid	Amine	alcohol	ketone	thiol	amide	amine	aniline	
Aspartic Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	
Benzenesulfonic Acid	Sulfonic Acid	pyridine	ketone	aldehyde	ether	ester	amide	
	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	
	Ketone	alcohol	ketone	thiol	amide	amine	aniline	
	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	
Camphoric acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	
Capric acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	
Genistein	Ketone	alcohol	ketone	thiol	amide	amine	aniline	
Genistein	Phenol	amine	amide	sulfoxide	n	pyridine	cyano	
Genistein	Ether	aromatic-N	amide	amine	aromatic_s	Sp2 amine	sulfoxide	
Cinnamic acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	
Citric Acid	Alcohol	alcohol	ketone	thiol	amide	amine	aniline	
Citric Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	
Clemizole	Pyrrolidine	*alcohol	pyridinium	*	*amide	nitro	*amine	
Cyclamic Acid	Amine	alcohol	ketone	thiol	amide	amine	aniline	
Cyclamic Acid	Sulfonic Acid	pyridine	ketone	aldehyde	ether	ester	amide	
	Amine	alcohol	ketone	thiol	amide	amine	aniline	
	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	
	Thiol	carboxylic acid	sodium	aldehyde	ketone	-N	cadmium	
Dimethylglycine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	
Dimethylglycine	Amine	alcohol	ketone	thiol	amide	amine	aniline	
D-ribose	Ether	aromatic-N	amide	amine	aromatic_s	Sp2 amine	sulfoxide	
D-ribose	Alcohol	alcohol	ketone	thiol	amide	amine	aniline	
Fumaric Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	
Galactaric acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	
Galactaric acid	alcohol	alcohol	ketone	thiol	amide	amine	aniline	
Chrysin	Ketone	alcohol	ketone	thiol	amide	amine	aniline	
Chrysin	Phenol	amine	amide	thiol	amide	amine	aniline	
Chrysin	Ether	aromatic-N	amide	sulfoxide	n	pyridine	cyano	
				amine	aromatic_s	Sp2 amine	sulfoxide	

TABLE II

Co-crystal Former		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Asparagine		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Asparagine		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Aspartic Acid		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Aspartic Acid		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Benzenesulfonic Acid		Carboxylic Acid	amine	metals	thioether		sulfate	
Benzoic Acid		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Caffeine		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Camphoric acid		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Capric acid		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Genistein		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Genistein		aldehyde		alcohol		ester	ether	chlorine
Genistein		chlorate	chlorine		cyano	ester	amine	nitrate
Cinnamic acid		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Citric Acid		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Citric Acid		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Clemizole		*carboxilic acid	*sulfonamide	*ketone	ether	triazole		oxime
Cyclamic Acid		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Cyclamic Acid		Carboxylic Acid	amine	metals	thioether		sulfate	
Cysteine		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Cysteine		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Cysteine			arsenic	chlorine	alcohol	potassium	Ru	Rb
Dimethylglycine		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Dimethylglycine		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
D-ribose		chlorate	chlorine		cyano	ester	amine	nitrate
D-ribose		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Fumaric Acid		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Galactaric acid		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Galactaric acid		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	metals
Chrysin		phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Chrysin		aldehyde		alcohol		ester	ether	chlorine
Chrysin		chlorate	chlorine		cyano	ester	amine	nitrate

TABLE II

Co-crystal Former									
Asparagine	metals	aldehyde	ester	ether	cyano		furan	bromine	
Asparagine	metals	aldehyde	ester	ether	cyano		furan	bromine	
Aspartic Acid	metals	aldehyde	ester	ether	cyano		furan	bromine	
Aspartic Acid	metals	aldehyde	ester	ether	cyano		furan	bromine	
Benzenesulfonic Acid									
	metals	aldehyde	ester	ether	cyano		furan	bromine	
	metals	aldehyde	ester	ether	cyano		furan	bromine	
	metals	aldehyde	ester	ether	cyano		furan	bromine	
	metals	aldehyde	ester	ether	cyano		furan	bromine	
Genistein	metals	aldehyde	ester	ether	cyano		furan	bromine	
Genistein	fluorine	bromine	iodine	ketone	sulfonic acid	sulfate	phosphate	phosphonic acid	
Genistein	bromine	aldehyde	ketone	peroxide	epoxide			heterocyclic-S	
Cinnamic acid	metals	aldehyde	ester	ether	cyano		furan	bromine	
Citric Acid	metals	aldehyde	ester	ether	cyano		furan	bromine	
Citric Acid	metals	aldehyde	ester	ether	cyano		furan	bromine	
Clemizole	*chlorine		thiol	n-heterocyclic ring	thionedisulfide	pyrrolidindione	iodine	hydrazone	
Cyclamic Acid	metals	aldehyde	ester	ether	cyano		furan	bromine	
Cyclamic Acid									
Cysteine	metals	aldehyde	ester	ether	cyano		furan	bromine	
Cysteine	metals	aldehyde	ester	ether	cyano		furan	bromine	
Cysteine	Sb								
Dimethylglycine	metals	aldehyde	ester	ether	cyano		furan	bromine	
Dimethylglycine	metals	aldehyde	ester	ether	cyano		furan	bromine	
D-ribose	bromine	aldehyde	ketone	peroxide	epoxide			heterocyclic-S	
D-ribose	metals	aldehyde	ester	ether	cyano		furan	bromine	
Fumaric Acid	metals	aldehyde	ester	ether	cyano		furan	bromine	
Galactaric acid	metals	aldehyde	ester	ether	cyano		furan	bromine	
Galactaric acid	aldehyde	ester	ether	ether	cyano		furan	bromine	
Chrysin	metals	aldehyde	ether	cyano		furan	bromine	chlorine	
Chrysin	fluorine	aldehyde	ester	ether	cyano		furan	bromine	
Chrysin	bromine	aldehyde	iodine	ketone	sulfonic acid	sulfate	phosphate	phosphonic acid	
Chrysin	bromine	aldehyde	ketone	peroxide	epoxide			heterocyclic-S	

## TABLE II

Co-crystal Former							
Asparagine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Asparagine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Aspartic Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Aspartic Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Benzenesulfonic Acid							
	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Camphoric acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Capric acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Genistein	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Genistein	carboxylic acid	nitro	sulfone	aniline			
Genistein	iodine	ester	ether	carboxylic acid	sulfate	sulfone	
Cinnamic acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Citric Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Citric Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Clemizole	thiocyanate	*bromine		hydroxamic acid	cyano	carboxamide	
Cyclamic Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Cyclamic Acid							
	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Cysteine							
	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Cysteine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Cysteine							
	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Dimethylglycine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Dimethylglycine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
D-ribose	iodine	ester	ether	carboxylic acid	sulfate	sulfone	
D-ribose	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Fumaric Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Galactaric acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Galactaric acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Galactaric acid	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	phosphate ester	
Chrysin	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	
Chrysin	carboxylic acid	nitro	sulfone	aniline			
Chrysin	iodine	ester	ether	carboxylic acid	sulfate	sulfone	



Co-crystal Former	phosphate ester	fluorine	carbamate	imidazole	BF4	
Asparagine	phosphate ester	fluorine	carbamate	imidazole	BF4	
Asparagine	phosphate ester	fluorine	carbamate	imidazole	BF4	
Aspartic Acid	phosphate ester	fluorine	carbamate	imidazole	BF4	
Aspartic Acid	phosphate ester	fluorine	carbamate	imidazole	BF4	
Benzenesulfonic Acid						
	phosphate ester	fluorine	carbamate	imidazole	BF4	
	phosphate ester	fluorine	carbamate	imidazole	BF4	
	phosphate ester	fluorine	carbamate	imidazole	BF4	
	phosphate ester	fluorine	carbamate	imidazole	BF4	
	phosphate ester	fluorine	carbamate	imidazole	BF4	
Benzoic Acid	phosphate ester	fluorine	carbamate	imidazole	BF4	
Caffeine	phosphate ester	fluorine	carbamate	imidazole	BF4	
Camphoric acid	phosphate ester	fluorine	carbamate	imidazole	BF4	
Capric acid	phosphate ester	fluorine	carbamate	imidazole	BF4	
Genistein	phosphate ester	fluorine	carbamate	imidazole	BF4	
Genistein						
Genistein		alcohol	phosphate	cyanamide		
Cinnamic acid	phosphate ester	fluorine	carbamate	imidazole	BF4	
Citric Acid	phosphate ester	fluorine	carbamate	imidazole	BF4	
Citric Acid	phosphate ester	fluorine	carbamate	imidazole	BF4	
Clemizole	*sulfonic acid	*phosphoric acid	ester	ether	fluorine	acetate thione
	phosphate ester	fluorine	carbamate	imidazole	BF4	
Cyclamic Acid						
Cyclamic Acid	phosphate ester	fluorine	carbamate	imidazole	BF4	
Cyclamic Acid						
Cysteine	phosphate ester	fluorine	carbamate	imidazole	BF4	
Cysteine	phosphate ester	fluorine	carbamate	imidazole	BF4	
Cysteine						
Dimethylglycine	phosphate ester	fluorine	carbamate	imidazole	BF4	
Dimethylglycine	phosphate ester	fluorine	carbamate	imidazole	BF4	
D-ribose		alcohol	phosphate	cyanamide		
D-ribose	phosphate ester	fluorine	carbamate	imidazole	BF4	
Fumaric Acid	phosphate ester	fluorine	carbamate	imidazole	BF4	
Galactaric acid	phosphate ester	fluorine	carbamate	imidazole	BF4	
Galactaric acid		fluorine	imidazole	BF4		
Chrysin	phosphate ester	fluorine	carbamate	imidazole	BF4	
Chrysin						
Chrysin		alcohol	phosphate	cyanamide		

TABLE II

Co-crystal Former		thiourea	iodine	epoxide	peroxide
Asparagine	N-SO <sub>2</sub>	thiourea	iodine		
Asparagine	N-SO <sub>2</sub>	thiourea	iodine		
Aspartic Acid	N-SO <sub>2</sub>	thiourea	iodine		
Aspartic Acid	N-SO <sub>2</sub>	thiourea	iodine		
Benzenesulfonic Acid					
Benzoic Acid	N-SO <sub>2</sub>	thiourea	iodine		
Caffeine	N-SO <sub>2</sub>	thiourea	iodine		
Camphoric acid	N-SO <sub>2</sub>	thiourea	iodine		
Capric acid	N-SO <sub>2</sub>	thiourea	iodine		
Genistein	N-SO <sub>2</sub>	thiourea	iodine		
Genistein					
Genistein					
Cinnamic acid	N-SO <sub>2</sub>	thiourea	iodine		
Citric Acid	N-SO <sub>2</sub>	thiourea	iodine	epoxide	
Citric Acid	N-SO <sub>2</sub>	thiourea	iodine		
Clemizole	dithiadiazocyclopentadienyl				
Cyclamic Acid	N-SO <sub>2</sub>	thiourea	iodine		
Cyclamic Acid					
Cysteine	N-SO <sub>2</sub>	thiourea	iodine		
Cysteine	N-SO <sub>2</sub>	thiourea	iodine		
Cysteine					
Dimethylglycine	N-SO <sub>2</sub>	thiourea	iodine		
Dimethylglycine	N-SO <sub>2</sub>	thiourea	iodine		
D-ribose					
D-ribose	N-SO <sub>2</sub>	thiourea	iodine	epoxide	
Fumaric Acid	N-SO <sub>2</sub>	thiourea	iodine		
Galactaric acid	N-SO <sub>2</sub>	thiourea	iodine		
Galactaric acid					
Chrysin	N-SO <sub>2</sub>	thiourea	iodine		
Chrysin					
Chrysin					

TABLE II

Co-crystal Former	Co-crystal Former Functional Group	Interacting Group							
Gentisic acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	pyridine	aniline
Gentisic acid	Phenol	amine	amide	sulfoxide	n	amine	cyano	pyridine	aniline
Glucamine, N-methyl	alcohol	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glucamine, N-methyl	Amine	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Gluconic Acid	Alcohol	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Gluconic Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glucosamine	alcohol	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glucuronic acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glucuronic acid	alcohol	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glucuronic acid	Aldehyde	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glutamic Acid	Amine	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glutamic Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glutamine	Amine	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glutamine	Amide	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glutamine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glutaric Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glycine	Amine	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glycine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glycolic Acid	Alcohol	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Glycolic Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Hippuric Acid	Amide	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Hippuric Acid	Amine	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Hippuric Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Histidine	Amine	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Histidine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Histidine									
Histidine	Imidazole	imidazole	chlorine	acetamide	carboxylate		thione		
Hydroquinone	Alcohol	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Hydroquinone	Phenol	amine	amide	sulfoxide	n	pyridine	cyano	pyridine	aniline
Imidazole	Amine	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline
Ipriflavone	Ether	aromatic-N	amide	amine	aromatic_s	Sp2 amine	sulfoxide	amine	aniline
Ipriflavone	Ketone	alcohol		thiol	amide	amine	aniline	amine	aniline
Isoleucine	Amine	alcohol	ketone	thiol	amide	amine	aniline	amine	aniline

TABLE II

Co-crystal Former	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	n-oxide	carboxylic acid
Gentic acid	aldehyde		alcohol		ester	ether		chlorine
Gentic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid	metals
Glucamine, N-methyl	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Glucamine, N-methyl	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
Gluconic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Gluconic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
Glucosamine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Glucuronic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Glucuronic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid	metals
Glucuronic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	aromatic	carboxylic acid
Glutamic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Glutamic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Glutamine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Glutamine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
Glutamine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Glutaric Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Glycine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Glycine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Glycolic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
Glycolic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Hippuric Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Hippuric Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Hippuric Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Histidine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Histidine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Histidine	nitro							
Histidine	phenol	cyanamide	ketone	cyano	Carboxylic Acid	alcohol		thiol
Hydroquinone	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
Hydroquinone	aldehyde		alcohol		ester	ether	n-oxide	chlorine
Imidazole	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid
Ipriflavone	chlorate	chlorine		cyano	ester	amine	nitro	nitrate
Ipriflavone	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		Carboxylic Acid
Isoleucine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine		carboxylic acid

## TABLE II

Co-crystal Former		metals	aldehyde	ester	ether	cyano	sulfonic acid	sulfate	furan	phosphate	bromine	phosphonic acid
Genticic acid	fluorine	aldehyde	iodine	ether	cyano			furan				
Genticic acid	aldehyde	ester	ether	ether								
Glucamine, N-methyl	metals	aldehyde	ester	ether	ether	cyano			furan			
Glucamine, N-methyl	metals	aldehyde	ester	ether	ether	cyano			furan			
Gluconic Acid	metals	aldehyde	ester	ether	ether	cyano			furan			
Gluconic Acid	metals	aldehyde	ester	ether	ether	cyano			furan			
Glucosamine	metals	aldehyde	ester	ether	ether	cyano			furan			
Glucuronic acid	aldehyde	ester	ether	cyano				furan				
Glucuronic acid	metals	aldehyde	ester	ether	ether	cyano			furan			
Glutamic Acid	metals	aldehyde	ester	ether	ether	cyano			furan			
Glutamic Acid	metals	aldehyde	ester	ether	ether	cyano			furan			
Glutamine	metals	aldehyde	ester	ether	ether	cyano			furan			
Glutamine	metals	aldehyde	ester	ether	ether	cyano			furan			
Glutamine	metals	aldehyde	ester	ether	ether	cyano			furan			
Glutaric Acid	metals	aldehyde	ester	ether	ether	cyano			furan			
Glycine	metals	aldehyde	ester	ether	ether	cyano			furan			
Glycine	metals	aldehyde	ester	ether	ether	cyano			furan			
Glycolic Acid	metals	aldehyde	ester	ether	ether	cyano			furan			
Glycolic Acid	metals	aldehyde	ester	ether	ether	cyano			furan			
Glycolic Acid	metals	aldehyde	ester	ether	ether	cyano			furan			
Hippuric Acid	metals	aldehyde	ester	ether	ether	cyano			furan			
Hippuric Acid	metals	aldehyde	ester	ether	ether	cyano			furan			
Hippuric Acid	metals	aldehyde	ester	ether	ether	cyano			furan			
Histidine	metals	aldehyde	ester	ether	ether	cyano			furan			
Histidine	metals	aldehyde	ester	ether	ether	cyano			furan			
		phosphinic acid										
		hemihydrate										
Histidine	amine	aldehyde	chlorine	sulfonyl				amide	fluorine			sulfonate ester
Hydroquinone	metals	aldehyde	ester	ether		cyano			furan			bromine
Hydroquinone	fluorine	bromine	iodine	ketone		sulfonic acid		sulfate	phosphate			phosphonic acid
Imidazole	metals	aldehyde	ester	ether		cyano			furan			bromine
Ipriiflavone	bromine	aldehyde	ketone	peroxide		epoxide						heterocyclic-S
Ipriiflavone	metals	aldehyde	ester	ether		cyano			furan			bromine
Isolucine	metals	aldehyde	ester	ether		cyano			furan			bromine

## TABLE II

Co-crystal Former	chlorine	s-heterocyclic nitro	pyridine sulfone	cyano	n-heterocyclic ketone	ketone
Gentisic acid	carboxylic acid	pyridine	pyridine	cyano	aniline	phosphate ester
Gentisic acid	s-heterocyclic	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glucamine, N-methyl	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glucamine, N-methyl	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Gluconic Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Gluconic Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glucosamine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glucuronic acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glucuronic acid	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	phosphate ester
Glucuronic acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glutamic Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glutamic Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glutamine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glutamine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glutamine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glutaric Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glycine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glycine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glycolic Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Glycolic Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Hippuric Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Hippuric Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Hippuric Acid	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Histidine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Histidine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Histidine						
Histidine						
Hydroquinone	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Hydroquinone	carboxylic acid	nitro	sulfone	aniline		
Imidazole	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Ipri flavone	iodine	ester	ether	carboxylic acid	sulfate	sulfone
Ipri flavone	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone
Isoleucine	chlorine	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone

TABLE II

Co-crystal Former	phosphate ester	fluorine	fluorine	carbamate	imidazole	BF4	alkane	aromatic
Gentisic acid	phosphate ester					BF4		
Gentisic acid		fluorine		imidazole	BF4			
Glucamine, N-methyl	phosphate ester			carbamate	imidazole	BF4		
Glucamine, N-methyl	phosphate ester			carbamate	imidazole	BF4		
Glucuronic Acid	phosphate ester			carbamate	imidazole	BF4		
Glucuronic Acid	phosphate ester			carbamate	imidazole	BF4		
Glucosamine	phosphate ester			carbamate	imidazole	BF4		
Glucuronic acid	phosphate ester			carbamate	imidazole	BF4		
Glucuronic acid		fluorine		imidazole	BF4			
Glucuronic acid	phosphate ester			carbamate	imidazole	BF4	alkane	aromatic
Glutamic Acid	phosphate ester			carbamate	imidazole	BF4		
Glutamic Acid	phosphate ester			carbamate	imidazole	BF4		
Glutamine	phosphate ester			carbamate	imidazole	BF4		
Glutamine	phosphate ester			carbamate	imidazole	BF4		
Glutamine	phosphate ester			carbamate	imidazole	BF4		
Glutamic Acid	phosphate ester			carbamate	imidazole	BF4		
Glycine	phosphate ester			carbamate	imidazole	BF4		
Glycine	phosphate ester			carbamate	imidazole	BF4		
Glycine	phosphate ester			carbamate	imidazole	BF4		
Glycolic Acid	phosphate ester			carbamate	imidazole	BF4		
Glycolic Acid	phosphate ester			carbamate	imidazole	BF4		
Hippuric Acid	phosphate ester			carbamate	imidazole	BF4		
Hippuric Acid	phosphate ester			carbamate	imidazole	BF4		
Hippuric Acid	phosphate ester			carbamate	imidazole	BF4		
Histidine	phosphate ester			carbamate	imidazole	BF4		
Histidine	phosphate ester			carbamate	imidazole	BF4		
Histidine								
Histidine								
Hydroquinone	phosphate ester			carbamate	imidazole	BF4		
Hydroquinone								
Imidazole	phosphate ester			carbamate	imidazole	BF4		
Imidazole		alcohol		phosphate	imidazole			
Ipriflavone	phosphate ester			carbamate	imidazole	BF4		
Ipriflavone	phosphate ester			carbamate	imidazole	BF4		
Isoleucine	phosphate ester			carbamate	imidazole	BF4		

TABLE II

Co-crystal Former					
Gentisic acid	N-SO2	thiourea	iodine		
Gentisic acid					
Glucamine, N-methyl					
Glucamine, N-methyl	N-SO2	thiourea	iodine		
Gluconic Acid	N-SO2	thiourea	iodine	epoxide	
Gluconic Acid	N-SO2	thiourea	iodine		
Glucosamine	N-SO2	thiourea	iodine	epoxide	
Glucuronic acid	N-SO2	thiourea	iodine		
Glucuronic acid					
Glucuronic acid	N-SO2	thiourea	iodine	epoxide	
Glutamic Acid	N-SO2	thiourea	iodine		
Glutamic Acid	N-SO2	thiourea	iodine		
Glutamic Acid	N-SO2	thiourea	iodine		
Glutamine	N-SO2	thiourea	iodine	epoxide	peroxide
Glutamine	N-SO2	thiourea	iodine		
Glutamic Acid	N-SO2	thiourea	iodine		
Glycine	N-SO2	thiourea	iodine		
Glycine	N-SO2	thiourea	iodine		
Glycolic Acid	N-SO2	thiourea	iodine	epoxide	
Glycolic Acid	N-SO2	thiourea	iodine		
Hippuric Acid	N-SO2	thiourea	iodine	epoxide	peroxide
Hippuric Acid	N-SO2	thiourea	iodine		
Hippuric Acid	N-SO2	thiourea	iodine		
Histidine	N-SO2	thiourea	iodine		
Histidine	N-SO2	thiourea	iodine		
Histidine					
Hydroquinone	N-SO2	thiourea	iodine	epoxide	
Hydroquinone					
Imidazole	N-SO2	thiourea	iodine		
Ipriflavone					
Ipriflavone	N-SO2	thiourea	iodine		
Isoleucine	N-SO2	thiourea	iodine		



TABLE II

Co-crystal Former	Co-crystal Former Functional Group	Interacting Group						
Isoleucine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Lactobionic acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Lactobionic acid	alcohol	alcohol	ketone	thiol	amide	amine	amine	aniline
Lactobionic acid	Ether	aromatic-N	amide	amine	aromatic_s	Sp2 amine	Sp2 amine	sulfoxide
Lauric acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Leucine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Leucine	Amine	alcohol	ketone	thiol	amide	amine	amine	aniline
Lysine	Amine	alcohol	ketone	thiol	amide	amine	amine	aniline
Lysine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Maleic	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Malic Acid	Alcohol	alcohol	ketone	thiol	amide	amine	amine	aniline
Malic Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Malonic	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Mandelic Acid	Alcohol	alcohol	ketone	thiol	amide	amine	amine	aniline
Mandelic Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Methionine	Amine	alcohol	ketone	thiol	amide	amine	amine	aniline
Methionine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Methionine	Thioether	-N	amide	amine	_s	Sp2 amine	Sp2 amine	sulfoxide
Nicotinamide	Pyridine	*alcohol		*	*amide	nitro	nitro	*amine
Nicotinamide	Amide	alcohol	ketone	thiol	amide	amine	amine	aniline
Nicotinic Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Nicotinic Acid	Pyridine	*alcohol		*	*amide	nitro	nitro	*amine
Orotic acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Orotic acid	Lactam	alcohol	ketone	thiol	amide	amine	amine	aniline
Oxalic acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Palmitic acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Pantoic acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Pantoic acid	alcohol	alcohol	ketone	thiol	amide	amine	amine	aniline
Pantoic acid	Phenol	amine	amide	sulfoxide	n	pyridine	pyridine	cyano
Phenylalanine	Amine	alcohol	ketone	thiol	amide	amine	amine	aniline
Phenylalanine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Piperazine	Amine	alcohol	ketone	thiol	amide	amine	amine	aniline
Procaine	Amine	alcohol	ketone	thiol	amide	amine	amine	aniline

TABLE II

Co-crystal Former	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Isoleucine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Lactobionic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Lactobionic acid	chlorate	chlorine		cyano	ester	amine	nitrate
Lauric acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Leucine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Leucine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Lysine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Lysine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Maleic	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Malic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Malic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Malonic	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Mandelic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Mandelic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Methionine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Methionine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Methionine	chlorate	chlorine		cyano	ester	amine	nitrate
Nicotinamide	*Carboxylic Acid	*sulfonamide	*ketone	ether	triazole		oxime
Nicotinamide	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Nicotinic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Nicotinic Acid	*Carboxylic Acid	*sulfonamide	*ketone	ether	triazole		oxime
Orotic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Orotic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Oxalic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Palmitic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Pamoic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Pamoic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Pamoic acid	aldehyde		alcohol		ester	ether	metals
Phenylalanine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	chlorine
Phenylalanine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Piperazine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Procaine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid

TABLE II

Co-crystal Former	metals	aldehyde	ester	ether	cyano		uran	bromine
Isoleucine	metals	aldehyde	ester	ether	cyano		uran	bromine
Lactobionic acid	metals	aldehyde	ester	ether	cyano		uran	bromine
Lactobionic acid	aldehyde	ester	ether	cyano		uran		chlorine
Lactobionic acid	bromine	aldehyde	ketone	peroxide	epoxide			heterocyclic-S
Lauric acid		aldehyde	ester	ether	cyano		uran	bromine
Leucine	metals	aldehyde	ester	ether	cyano		uran	bromine
Leucine	metals	aldehyde	ester	ether	cyano		uran	bromine
Lysine	metals	aldehyde	ester	ether	cyano		uran	bromine
Lysine	metals	aldehyde	ester	ether	cyano		uran	bromine
Maleic	metals	aldehyde	ester	ether	cyano		uran	bromine
Malic Acid	metals	aldehyde	ester	ether	cyano		uran	bromine
Malic Acid	metals	aldehyde	ester	ether	cyano		uran	bromine
Malonic	metals	aldehyde	ester	ether	cyano		uran	bromine
Mandellic Acid	metals	aldehyde	ester	ether	cyano		uran	bromine
Mandellic Acid	metals	aldehyde	ester	ether	cyano		uran	bromine
Methionine	metals	aldehyde	ester	ether	cyano		uran	bromine
Methionine	metals	aldehyde	ester	ether	cyano		uran	bromine
Methionine	bromine	aldehyde	ketone	peroxide	epoxide	Ag	Se	heterocyclic-S
Nicotinamide	*chlorine		thiol	n-heterocyclic ring	thionedisulfide	pyrrolidindione	iodine	hydrazone
Nicotinamide	metals	aldehyde	ester	ether	cyano		uran	bromine
Nicotinic Acid	metals	aldehyde	ester	ether	cyano		uran	bromine
Nicotinic Acid	*chlorine		thiol	n-heterocyclic ring	thionedisulfide	pyrrolidindione	iodine	hydrazone
Orotic acid		aldehyde	ester	ether	cyano		uran	bromine
Orotic acid	metals	aldehyde	ester	ether	cyano		uran	bromine
Oxalic acid		aldehyde	ester	ether	cyano		uran	bromine
Palmitic acid		aldehyde	ester	ether	cyano		uran	bromine
Pamoic acid		aldehyde	ester	ether	cyano		uran	bromine
Pamoic acid	aldehyde	ester	ether	cyano		uran	bromine	chlorine
Pamoic acid	fluorine	bromine	iodine	ketone	sulfonic acid	sulfate	phosphate	phosphonic acid
Phenylalanine	metals	aldehyde	ester	ether	cyano		uran	bromine
Phenylalanine	metals	aldehyde	ester	ether	cyano		uran	bromine
Piperazine	metals	aldehyde	ester	ether	cyano		uran	bromine
Procaine	metals	aldehyde	ester	ether	cyano		uran	bromine

TABLE II

Co-crystal Former	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Isoleucine	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Lactobionic acid	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Lactobionic acid	s-heterocyclic	pyridine	ether	ether	carboxylic acid	sulfate	phosphate ester	sulfone
Lactobionic acid	iodine	ester	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Lactic acid	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Leucine	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Leucine	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Lysine	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Lysine	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Maleic	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Maleic Acid	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Maleic Acid	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Malonic	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Mandelic Acid	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Mandelic Acid	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Methionine	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Methionine	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Methionine	iodine	ester	ether	ether	carboxylic acid	sulfate	sulfone	sulfone
Nicotinamide	thiocyanate	*bromine			hydroxamic acid	cyano	carboxamide	carboxamide
Nicotinamide	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Nicotinic Acid	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Nicotinic Acid	thiocyanate	*bromine			hydroxamic acid	cyano	carboxamide	carboxamide
Orotic acid	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Orotic acid	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Oxalic acid	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Palmitic acid	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Pantoic acid	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Pantoic acid	s-heterocyclic	pyridine	cyano	cyano	n-heterocyclic	ketone	phosphate ester	phosphate ester
Pantoic acid	carboxylic acid	nitro	sulfone	aniline	aniline			
Phenylalanine	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Phenylalanine	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Piperazine	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone
Procaine	chlorine	s-heterocyclic	pyridine	pyridine	cyano	n-heterocyclic	ketone	ketone

## TABLE II

Co-crystal Former	phosphate ester	fluorine	phosphate ester	fluorine	carbamate	imidazole	BF4
Isoleucine	phosphate ester			fluorine	carbamate	imidazole	BF4
Lactobionic acid	phosphate ester			fluorine	carbamate	imidazole	BF4
Lactobionic acid		fluorine		carbamate	imidazole	BF4	
Lauric acid	phosphate ester	alcohol			phosphate	cyanamide	
Leucine	phosphate ester			fluorine	carbamate	imidazole	BF4
Leucine	phosphate ester			fluorine	carbamate	imidazole	BF4
Lysine	phosphate ester			fluorine	carbamate	imidazole	BF4
Lysine	phosphate ester			fluorine	carbamate	imidazole	BF4
Maleic	phosphate ester			fluorine	carbamate	imidazole	BF4
Malic Acid	phosphate ester			fluorine	carbamate	imidazole	BF4
Malic Acid	phosphate ester			fluorine	carbamate	imidazole	BF4
Malonic	phosphate ester			fluorine	carbamate	imidazole	BF4
Mandelic Acid	phosphate ester			fluorine	carbamate	imidazole	BF4
Mandelic Acid	phosphate ester			fluorine	carbamate	imidazole	BF4
Methionine	phosphate ester			fluorine	carbamate	imidazole	BF4
Methionine	phosphate ester			fluorine	carbamate	imidazole	BF4
Methionine	phosphate ester	alcohol			phosphate		
Nicotinamide	*sulfonic acid	*phosphoric acid	N-oxide		ester	ether	fluorine acetate thione
Nicotinamide	phosphate ester		fluorine		carbamate	imidazole	BF4
Nicotinic Acid	phosphate ester		fluorine		carbamate	imidazole	BF4
Nicotinic Acid	*sulfonic acid	*phosphoric acid	N-oxide		ester	ether	fluorine acetate thione
Orotic acid	phosphate ester		fluorine		carbamate	imidazole	BF4
Orotic acid	phosphate ester		fluorine		carbamate	imidazole	BF4
Oxalic acid	phosphate ester		fluorine		carbamate	imidazole	BF4
Palmitic acid	phosphate ester		fluorine		carbamate	imidazole	BF4
Pantoic acid	phosphate ester		fluorine		carbamate	imidazole	BF4
Pantoic acid	phosphate ester	fluorine	carbamate		imidazole	BF4	
Pantoic acid							
Phenylalanine	phosphate ester		fluorine		carbamate	imidazole	BF4
Phenylalanine	phosphate ester		fluorine		carbamate	imidazole	BF4
Piperazine	phosphate ester		fluorine		carbamate	imidazole	BF4
Procaine	phosphate ester		fluorine		carbamate	imidazole	BF4

TABLE II

Co-crystal Former					
Isoleucine	N-SO <sub>2</sub>	thiourea	iodine		
Lactobionic acid	N-SO <sub>2</sub>	thiourea	iodine		
Lactobionic acid					
Lactobionic acid					
Lauric acid	N-SO <sub>2</sub>	thiourea	iodine		
Leucine	N-SO <sub>2</sub>	thiourea	iodine		
Leucine	N-SO <sub>2</sub>	thiourea	iodine		
Lysine	N-SO <sub>2</sub>	thiourea	iodine		
Lysine	N-SO <sub>2</sub>	thiourea	iodine		
Maleic	N-SO <sub>2</sub>	thiourea	iodine		
Malic Acid	N-SO <sub>2</sub>	thiourea	iodine	epoxide	
Malic Acid	N-SO <sub>2</sub>	thiourea	iodine		
Malonic	N-SO <sub>2</sub>	thiourea	iodine		
Mandelic Acid	N-SO <sub>2</sub>	thiourea	iodine	epoxide	
Mandelic Acid	N-SO <sub>2</sub>	thiourea	iodine		
Methionine	N-SO <sub>2</sub>	thiourea	iodine		
Methionine	N-SO <sub>2</sub>	thiourea	iodine		
Methionine					
Nicotinamide	dithiadiazocyclopentadienyl				
Nicotinamide	N-SO <sub>2</sub>	thiourea	iodine	epoxide	peroxide
Nicotinic Acid	N-SO <sub>2</sub>	thiourea	iodine		
Nicotinic Acid	dithiadiazocyclopentadienyl				
Orotic acid	N-SO <sub>2</sub>	thiourea	iodine		
Orotic acid	N-SO <sub>2</sub>	thiourea	iodine	epoxide	peroxide
Oxalic acid	N-SO <sub>2</sub>	thiourea	iodine		
Palmitic acid	N-SO <sub>2</sub>	thiourea	iodine		
Pamoic acid	N-SO <sub>2</sub>	thiourea	iodine		
Pamoic acid					
Pamoic acid					
Phenylalanine	N-SO <sub>2</sub>	thiourea	iodine		
Phenylalanine	N-SO <sub>2</sub>	thiourea	iodine		
Piperazine	N-SO <sub>2</sub>	thiourea	iodine		
Procaine	N-SO <sub>2</sub>	thiourea	iodine		

TABLE II

Co-crystal Former	Co-crystal Former Functional Group	Interacting Group						
Procaine	Ketone	alcohol		thiol	amide	amine	amine	aniline
Proline	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Proline	Amine	alcohol	ketone	thiol	amide	amine	amine	aniline
p-Toluenesulfonic acid	Sulfonic Acid	pyridine	ketone	aldehyde	ether	ester		amide
Pyridoxamine	Alcohol	alcohol	ketone	thiol	amide	amine	amine	aniline
Pyridoxamine	Amine	alcohol	ketone	thiol	amide	amine	amine	aniline
Pyridoxamine	Pyridine	*alcohol		*	*amide	nitro		*amine
Pyridoxine	Pyridine	*alcohol	pyridinium	*	*amide	nitro		*amine
(4-Pyridoxic Acid)	Pyridine							
Pyridoxine	Alcohol	alcohol	ketone	thiol	amide	amine		aniline
(4-Pyridoxic Acid)	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Pyroglutamic acid	Lactam	alcohol	ketone	thiol	amide	amine	amine	aniline
Pyroglutamic acid	Ketone	alcohol		thiol	amide	amine	amine	aniline
Quercetin	Phenol	amine	amide	sulfoxide	n	pyridine	cyano	
Quercetin	Ether	aromatic-N	amide	amine	aromatic s	Sp2 amine	sulfoxide	
Resveratrol	Ketone	alcohol		thiol	amide	amine	amine	aniline
Resveratrol	Phenol	amine	amide	sulfoxide	n	pyridine	cyano	
Saccharin	Amide	alcohol	ketone	thiol	amide	amine	amine	aniline
Saccharin	Ketone	alcohol		thiol	amide	amine	amine	aniline
Saccharin	Sulfoxide	pyridine	ketone		ether	ester		amide
Saccharin	Amine	alcohol	ketone	thiol	amide			aniline
Salicylic Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Salicylic Acid	Alcohol	alcohol	ketone	thiol	amide	amine	amine	aniline
Salicylic Acid, 4-amino	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Salicylic Acid, 4-amino	alcohol	alcohol	ketone	thiol	amide	amine	amine	aniline
Salicylic Acid, 4-amino	Amine	alcohol	ketone	thiol	amide	amine	amine	aniline
Sebacic acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Serine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline
Serine	Amine	alcohol	ketone	thiol	amide	amine	amine	aniline
Serine	Alcohol	alcohol	ketone	thiol	amide	amine	amine	aniline
Stearic acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine	amine	aniline

TABLE II

Co-crystal Former	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Procaine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Proline	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
p-Toluenesulfonic acid	Carboxylic Acid	amine	metals	thioether		sulfate	alcohol
Pyridoxamine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Pyridoxamine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Pyridoxamine	*Carboxylic Acid	*sulfonamide	*ketone	ether	triazole	ammonium	oxime
Pyridoxine	*Carboxylic Acid	*sulfonamide	*ketone	ether	triazole	ammonium	oxime
Pyridoxine (4-Pyridoxic Acid)	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Pyroglutamic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Pyroglutamic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Quercetin	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Quercetin	aldehyde		alcohol		ester	n-oxide	chlorine
Quercetin	chlorate	chlorine		cyano	ester	amine	nitrate
Resveratrol	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Resveratrol	aldehyde		alcohol		ester	ether	chlorine
Saccharin	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Saccharin	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Saccharin	Carboxylic Acid	amine	metals	thioether		sulfate	alcohol
Saccharin	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Salicylic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Salicylic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Salicylic Acid, 4-amino	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Salicylic Acid, 4-amino	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	metals
Salicylic Acid, 4-amino	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Sebacic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Serine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Serine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Serine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxylic acid
Stearic acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid



TABLE II

Co-crystal Former	metals	aldehyde	ester	ether	cyano		furane	bromine
Procaine	metals	aldehyde	ester	ether	cyano		furane	bromine
Proline	metals	aldehyde	ester	ether	cyano		furane	bromine
p-Toluenesulfonic acid								
Pyridoxamine	metals	aldehyde	ester	ether	cyano		furane	bromine
Pyridoxamine	metals	aldehyde	ester	ether	cyano		furane	bromine
Pyridoxamine	*chlorine		thiol	n-heterocyclic ring	thionedisulfide		iodine	hydrazone
Pyridoxine (4-Pyridoxic Acid)	*chlorine		thiol	n-heterocyclic ring	thionedisulfide	pyrrolidindione	iodine	hydrazone
Pyridoxine								
(4-Pyridoxic Acid)	metals	aldehyde	ester	ether	cyano		furane	bromine
Pyroglutamic acid	metals	aldehyde	ester	ether	cyano		furane	bromine
Pyroglutamic acid	metals	aldehyde	ester	ether	cyano		furane	bromine
Quercetin	metals	aldehyde	ester	ether	cyano		furane	bromine
Quercetin	fluorine	bromine	iodine	ketone	sulfonic acid	sulfate	phosphate	phosphonic acid
Quercetin	bromine	aldehyde	ketone	peroxide	epoxide			heterocyclic-S
Resveratrol	metals	aldehyde	ester	ether	cyano		furane	bromine
Resveratrol	fluorine	bromine	iodine	ketone	sulfonic acid	sulfate	phosphate	phosphonic acid
Saccharin	metals	aldehyde	ester	ether	cyano		furane	bromine
Saccharin	metals	aldehyde	ester	ether	cyano		furane	bromine
Saccharin								
Saccharin	metals	aldehyde	ester	ether	cyano		furane	bromine
Salicylic Acid	metals	aldehyde	ester	ether	cyano		furane	bromine
Salicylic Acid	metals	aldehyde	ester	ether	cyano		furane	bromine
Salicylic Acid, 4-amino	metals	aldehyde	ester	ether	cyano		furane	bromine
Salicylic Acid, 4-amino	aldehyde	ester	ether	cyano		furane	bromine	chlorine
Salicylic Acid, 4-amino	metals	aldehyde	ester	ether	cyano		furane	bromine
Sebacic acid	metals	aldehyde	ester	ether	cyano		furane	bromine
Serine	metals	aldehyde	ester	ether	cyano		furane	bromine
Serine	metals	aldehyde	ester	ether	cyano		furane	bromine
Serine	metals	aldehyde	ester	ether	cyano		furane	bromine
Stearic acid	metals	aldehyde	ester	ether	cyano		furane	bromine

## TABLE II

[illegible]



TABLE II

Co-crystal Former					
Procaine	N-SO <sub>2</sub>	thiourea	iodine		
Proline	N-SO <sub>2</sub>	thiourea	iodine		
Proline	N-SO <sub>2</sub>	thiourea	iodine		
p-Toluenesulfonic acid					
Pyridoxamine	N-SO <sub>2</sub>	thiourea	iodine	epoxide	
Pyridoxamine	N-SO <sub>2</sub>	thiourea	iodine		
Pyridoxamine	dithiadiazocyclopentadienyl				
Pyridoxine	dithiadiazocyclopentadienyl				
(4-Pyridoxic Acid)					
Pyridoxine	N-SO <sub>2</sub>	thiourea	iodine	epoxide	
(4-Pyridoxic Acid)	N-SO <sub>2</sub>	thiourea	iodine		
Pyroglutamic acid	N-SO <sub>2</sub>	thiourea	iodine	epoxide	peroxide
Pyroglutamic acid	N-SO <sub>2</sub>	thiourea	iodine		
Quercetin	N-SO <sub>2</sub>	thiourea	iodine		
Quercetin					
Quercetin					
Resveratrol	N-SO <sub>2</sub>	thiourea	iodine		
Resveratrol					
Saccharin	N-SO <sub>2</sub>	thiourea	iodine	epoxide	peroxide
Saccharin	N-SO <sub>2</sub>	thiourea	iodine		
Saccharin					
Saccharin	N-SO <sub>2</sub>	thiourea	iodine		
Salicylic Acid	N-SO <sub>2</sub>	thiourea	iodine		
Salicylic Acid	N-SO <sub>2</sub>	thiourea	iodine	epoxide	
Salicylic Acid, 4-amino	N-SO <sub>2</sub>	thiourea	iodine		
Salicylic Acid, 4-amino					
Salicylic Acid, 4-amino	N-SO <sub>2</sub>	thiourea	iodine		
Sebacic acid	N-SO <sub>2</sub>	thiourea	iodine		
Serine	N-SO <sub>2</sub>	thiourea	iodine		
Serine	N-SO <sub>2</sub>	thiourea	iodine		
Serine	N-SO <sub>2</sub>	thiourea	iodine		
Stearic acid	N-SO <sub>2</sub>	thiourea	iodine	epoxide	

TABLE II

Co-crystal Former	Co-crystal Former Functional Group	Interacting Group				
Succinic Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine
Tartaric Acid	Carboxylic Acid	alcohol	ketone	thiol	amide	amine
Threonine	Amine	alcohol	ketone	thiol	amide	amine
Threonine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine
Threonine	alcohol	alcohol	ketone	thiol	amide	amine
Tris	Amine	alcohol	ketone	thiol	amide	amine
Tris	Alcohol	alcohol	ketone	thiol	amide	amine
Tryptophan	Amine	alcohol	ketone	thiol	amide	amine
Tryptophan	Carboxylic Acid	alcohol	ketone	thiol	amide	amine
Tryptophan	Indole	*alcohol	pyridinium	*	*amide	nitro
Tyrosine	Amine	alcohol	ketone	thiol	amide	amine
Tyrosine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine
Tyrosine	Alcohol	alcohol	ketone	thiol	amide	amine
Urea	Ketone	alcohol		thiol	amide	amine
Urea	Amine	alcohol	ketone	thiol	amide	amine
Urea	Amide	alcohol	ketone	thiol	amide	amine
Valine	Amine	alcohol	ketone	thiol	amide	amine
Valine	Carboxylic Acid	alcohol	ketone	thiol	amide	amine
Vitamin K5	Amine	alcohol	ketone	thiol	amide	amine
Vitamin K5	Alcohol	alcohol	ketone	thiol	amide	amine
Xylitol	Alcohol	alcohol	ketone	thiol	amide	amine

TABLE II

Co-crystal Former	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Succinic Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Tartaric Acid	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Threonine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Threonine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Threonine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Tris	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Tris	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Tryptophan	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Tryptophan	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Tryptophan	*carboxilic acid	*sulfonamide	*ketone	ether	triazole	ammonium	oxime
Tyrosine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Tyrosine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Tyrosine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Urea	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Urea	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Urea	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Valine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Valine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Valine	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Vitamin K5	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	carboxilic acid
Vitamin K5	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid
Xylitol	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	Carboxylic Acid

TABLE II

Co-crystal Former	metals	aldehyde	ester	ether	cyano	pyrrolidindione	iodine	bromine
Succinic Acid	metals	aldehyde	ester	ether	cyano		iodine	bromine
Tartaric Acid	metals	aldehyde	ester	ether	cyano		iodine	bromine
Threonine	metals	aldehyde	ester	ether	cyano		iodine	bromine
Threonine	metals	aldehyde	ester	ether	cyano		iodine	bromine
Threonine	metals	aldehyde	ester	ether	cyano		iodine	bromine
Tris	metals	aldehyde	ester	ether	cyano		iodine	bromine
Tris	metals	aldehyde	ester	ether	cyano		iodine	bromine
Tryptophan	metals	aldehyde	ester	ether	cyano		iodine	bromine
Tryptophan	metals	aldehyde	ester	ether	cyano		iodine	bromine
Tryptophan	*chlorine		thiol	n-heterocyclic ring	thionedisulfide		iodine	hydrazone
Tyrosine	metals	aldehyde	ester	ether	cyano		iodine	bromine
Tyrosine	metals	aldehyde	ester	ether	cyano		iodine	bromine
Tyrosine	metals	aldehyde	ester	ether	cyano		iodine	bromine
Urea	metals	aldehyde	ester	ether	cyano		iodine	bromine
Urea	metals	aldehyde	ester	ether	cyano		iodine	bromine
Urea	metals	aldehyde	ester	ether	cyano		iodine	bromine
Valine	metals	aldehyde	ester	ether	cyano		iodine	bromine
Valine	metals	aldehyde	ester	ether	cyano		iodine	bromine
Vitamin K5	metals	aldehyde	ester	ether	cyano		iodine	bromine
Vitamin K5	metals	aldehyde	ester	ether	cyano		iodine	bromine
Xylitol	metals	aldehyde	ester	ether	cyano		iodine	bromine



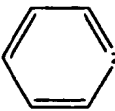
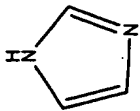
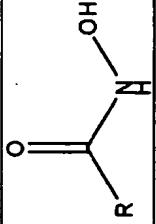

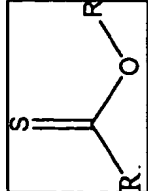
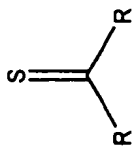




TABLE II

Co-crystal Former					
Succinic Acid	N-SO <sub>2</sub>	thiourea	iodine		
Tartaric Acid	N-SO <sub>2</sub>	thiourea	iodine		
Threonine	N-SO <sub>2</sub>	thiourea	iodine		
Threonine	N-SO <sub>2</sub>	thiourea	iodine		
Threonine	N-SO <sub>2</sub>	thiourea	iodine	epoxide	
Tris	N-SO <sub>2</sub>	thiourea	iodine		
Tris	N-SO <sub>2</sub>	thiourea	iodine	epoxide	
Tryptophan	N-SO <sub>2</sub>	thiourea	iodine		
Tryptophan	N-SO <sub>2</sub>	thiourea	iodine		
Tryptophan	N-SO <sub>2</sub>	thiourea	iodine		
Tryptophan	dithiadiazocyclopentadienyl				
Tyrosine	N-SO <sub>2</sub>	thiourea	iodine		
Tyrosine	N-SO <sub>2</sub>	thiourea	iodine		
Tyrosine	N-SO <sub>2</sub>	thiourea	iodine	epoxide	
Urea	N-SO <sub>2</sub>	thiourea	iodine		
Urea	N-SO <sub>2</sub>	thiourea	iodine		
Urea	N-SO <sub>2</sub>	thiourea	iodine	epoxide	peroxide
Valine	N-SO <sub>2</sub>	thiourea	iodine		
Valine	N-SO <sub>2</sub>	thiourea	iodine		
Vitamin K5	N-SO <sub>2</sub>	thiourea	iodine		
Vitamin K5	N-SO <sub>2</sub>	thiourea	iodine	epoxide	
Xylitol	N-SO <sub>2</sub>	thiourea	iodine	epoxide	

TABLE III

Functional Group	Functional Group Structure	Interacting Group					
pyridine		*alcohol	pyridinium	*amide	nitro		*amine
imidazole		imidazole	chlorine	acetamide	carboxylate	thione	
Hydroxamic acid		hydroxamic acid	alcohol	phosphinic ester	alkane	pyridine	
peroxide	$R-O-O-H$	ester	peroxide	amide	ether	alkane	
epoxide		alkane	bromine	alcohol	ester	epoxide	
thioester		aromatic	thioester	alkane	sulfamide	hydroxy	
thioketone		alkane	thioketone	ketone	SULFAMIDE	AMINE	

### TABLE III

[illegible]

TABLE III

Functional Group										
pyridine	alkyne	thiol	n-heterocyclic ring	thionedisulfide	pyrrolidindione	iodine	hydrazone	thiocyanate	*bromine	
imidazole	phosphinic acid hemihydrate	chlorine	sulfonyl	sulfoxide	amide	fluorine	sulfonate ester			
Hydroxamic acid										
peroxide	azide	phosphine oxide	sulfonamide	aniline						
epoxide	alkyne		ammonium	fluorine	nitro	amine	cyano			
thioester										
thioketone	AZOXY	potassium	epoxide	n-oxide	cyano	iron	cobalt	amine	sulfate	

TABLE III

Functional Group	aromatic	hydroxamic acid	cyano	carboxamide	*sulfonic acid	*phosphoric acid	N-oxide	ester	ether	fluorine
pyridine										
imidazole										
Hydroxamic acid										
peroxide										
epoxide										
thioester										
thioketone										

TABLE III

Functional Group									
pyridine	acetate	thione	dithiadiazocyclopentadienyl						
imidazole									
Hydroxamic acid									
peroxide									
epoxide									
thioester									
thioketone									

TABLE III

Functional Group	Functional Group Structure	Interacting Group					
nitrate ester	$\text{—O—NO}_2$	aromatic	amide	alkane	chlorine	nitrate ester	
Thiophosphate ester-O	$\begin{array}{c} \text{S} \\    \\ \text{—O—P—OH} \end{array}$		imidazole	cyclic amide			
Phosphate ester.	$\begin{array}{c} \text{O} \\    \\ \text{—O—P—OH} \end{array}$	amine					
		aromatic	alcohol	phosphate ester	aromatic N-ring	pyridine	
Ketone	$\begin{array}{c} \text{O} \\    \\ \text{R} \quad \text{R} \end{array}$	alcohol	ketone	thiol	amide	amine	
Aldehyde	$\begin{array}{c} \text{O} \\    \\ \text{R} \quad \text{H} \end{array}$	alcohol	ketone	thiol	amide	amine	
Thiol	$\text{R—SH}$	carboxylic acid	sodium	aldehyde	ketone	aromatic-N	
Alcohol	$\text{R—OH}$	alcohol	ketone	thiol	amide	amine	



### TABLE III

Functional Group									
nitrate ester	bromine	alcohol	ether	acetate					
Thiophosphate ester-O									
Phosphate ester	aniline	amine		sodium	potassium	lithium	carboxylic acid	amide	alkane
Ketone	aniline	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	aromatic	carboxilic acid
Aldehyde	aniline	phenol	phosphate	sulfate	sulfone	nitrate	pyndine	aromatic	carboxilic acid
Thiol	cadmium	alkane	arsenic	chlorine	alcohol	potassium	Ru	aromatic	Rb
Alcohol	aniline	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	aromatic	carboxilic acid

TABLE III

Functional Group										
nitrate ester										
Thiophosphate ester-O										
Phosphate ester										
Ketone	metals	aldehyde	ester	ether	cyano	furan	bromine	chlorine		
Aldehyde	metals	aldehyde	ester	ether	cyano	furan	bromine	chlorine		
Thiol	Sb									
Alcohol	metals	aldehyde	ester	ether	cyano	furan	bromine	chlorine		

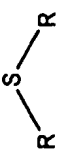



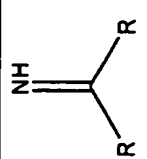


### TABLE III

[illegible]

### TABLE III

Functional Group									
nitrate ester									
Thiophosphate ester-O									
Phosphate ester									
Ketone	BF4	alkane	aromatic	N-SO2	thiourea	iodine			
Aldehyde	BF4	alkane	aromatic	N-SO2	thiourea	iodine	epoxide		
Thiol									
Alcohol	BF4	alkane	aromatic	N-SO2	thiourea	iodine	epoxide		

TABLE III

Functional Group	Functional Group Structure	Interacting Group						
Thioether		aromatic-N	amide	amine	aromatic_s	Sp2 amine		
Ether		aromatic-N	amide	amine	aromatic_s	Sp2 amine		
Cyanamide		cyano	amine	potassium	aromatic-N	bromine		
Thiocyanate		aromatic-S	ester	ether				
sp2 amine		thioether	ether	metals	MoOCl4	BF4		
Amine primary		alcohol	ketone	thiol	amide	amine		
Amine secondary		alcohol	ketone	thiol	amide	amine		

### TABLE III

Functional Group										
Thioether	sulfoxide	chlorate	chlorine	alkyne	cyano	ester	amine	nitro	nitrate	
Ether	sulfoxide	chlorate	chlorine	alkyne	cyano	ester	amine	nitro	nitrate	
Cyanamide	sodium	imidazole	ether	n-heterocyclic	alcohol	cesium	Ag			
Thiocyanate										
sP2 amine	bromine	chlorine		Sp2 amine	sulfate	Osmium				
Amine primary	aniline	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	aromatic	carboxylic acid	
Amine secondary	aniline	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	aromatic	carboxylic acid	

### TABLE III

Functional Group									
Thioether	bromine	aldehyde	ketone	peroxide	epoxide	Ag	Se	heterocyclic-S	iodine
Ether	bromine	aldehyde	ketone	peroxide	epoxide	Ag	Se	heterocyclic-S	iodine
Cyanamide									
Thiocyanate									
sp2 amine									
Amine primary	metals	aldehyde	ester	ether	cyano		furan	bromine	chlorine
Amine secondary	metals	aldehyde	ester	ether	cyano		furan	bromine	chlorine

### TABLE III

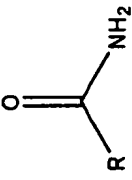
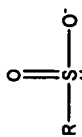
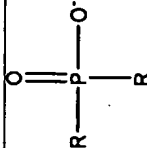
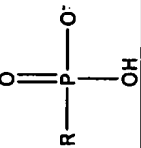
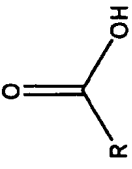
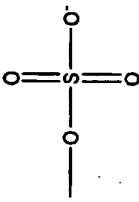
Functional Group										
Thioether	ester	ether	carboxylic acid	sulfate	sulfone	alkane	alcohol		phosphate	
Ether	ester	ether	carboxylic acid	sulfate	sulfone	alkane	alcohol		phosphate	cyanamide
Cyanamide										
Thiocyanate										
sp <sup>2</sup> amine										
Amine primary	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	phosphate ester		fluorine	carbamate	imidazole
Amine secondary	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	phosphate ester		fluorine	carbamate	imidazole



### TABLE III

Functional Group										
Thioether										
Ether										
Cyanamide										
Thiocyanate										
sp <sup>2</sup> amine										
Amine primary	BF <sub>4</sub>	alkane	aromatic	N-SO <sub>2</sub>	thiourea	iodine				
Amine secondary	BF <sub>4</sub>	alkane	aromatic	N-SO <sub>2</sub>	thiourea	iodine				

TABLE III

Functional Group	Functional Group Structure	Interacting Group						
Amine tertiary	$R_3-N$	alcohol	ketone	thiol	amide	amine		
Amide		alcohol	ketone	thiol	amide	amine		
Sulfonic acid		pyridine	ketone	aldehyde	ether	ester		
Phosphinic acid		alkane	potassium	lithium	n-heterocyclic	oxime		
Phosphonic acid		alkane	potassium	lithium	n-heterocyclic	oxime		
Carboxylic acid		alcohol	ketone	thiol	amide	amine		
Sulfate ester		pyridine	ketone	aldehyde	ether	ester		

### TABLE III

Functional Group								
Amine tertiary	aniline	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	aromatic carboxylic acid
Amide	aniline	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	aromatic carboxylic acid
Sulfonic acid	amide	carboxylic acid	amine	metals	thioether		sulfate	alcohol
Phosphinic acid	amide	phenol	aromatic	amine	alcohol		metals	
Phosphonic acid	amide	phenol	aromatic	amine	alcohol		metals	Sp <sup>2</sup> amine carboxylic acid
Carboxylic acid	aniline	phenol	phosphate	sulfate	sulfone	nitrate	pyridine	aromatic carboxylic acid
Sulfate ester	amide	carboxylic acid	amine	metals	thioether	sulfate	alcohol	

TABLE III

Functional Group	metals	aldehyde	ester	ether	cyano		furan	bromine	chlorine
Amine tertiary									
Amide	metals	aldehyde	ester	ether	cyano		furan	bromine	chlorine
Sulfonic acid									
Phosphinic acid									
Phosphonic acid	aniline	ether	phosphonic acid	aromatic-N	ketone		aldehyde	imidazole	
Carboxylic acid	metals	aldehyde	ester	ether	cyano		furan	bromine	chlorine
Sulfate ester									

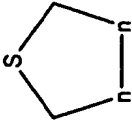
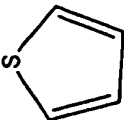
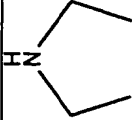
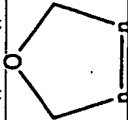
TABLE III

Functional Group	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	phosphate ester	fluorine	carbamate	imidazole
Amine tertiary									
Amide	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	phosphate ester	fluorine	carbamate	imidazole
Sulfonic acid									
Phosphinic acid									
Phosphonic acid									
Carboxylic acid	s-heterocyclic	pyridine	cyano	n-heterocyclic	ketone	phosphate ester	fluorine	carbamate	imidazole
Sulfate ester									

### TABLE III

Functional Group						
Amine tertiary	BF <sub>4</sub>	alkane	aromatic	N-SO <sub>2</sub>	thiourea	iodine
Amide	BF <sub>4</sub>	alkane	aromatic	N-SO <sub>2</sub>	thiourea	iodine epoxide peroxide
Sulfonic acid						
Phosphinic acid						
Phosphonic acid						
Carboxylic acid	BF <sub>4</sub>	alkane	aromatic	N-SO <sub>2</sub>	thiourea	iodine
Sulfate ester						

TABLE III

Functional Group	Functional Group Structure	Interacting Group						
Oxime	$C=N-OH$	alcohol	alkane	amine	amide	ether		
Nitrile	$-C\equiv N$	metal	ketone	phenol	alcohol			
Diazo	$RH_2C-N=N-CH_2R$	Oxime						
Nitro	$NO_2$	pyridine	ketone	aldehyde	ether	ester		
S-heterocyclic ring		alcohol	thio ketone	thio ether	s-heterocyclic ketone			
Thiophene		chlorine	fluorine	amide	ketone	NO		
N-heterocyclic ring		alcohol	thio ketone	thio ether	s-heterocyclic ketone			
O-heterocyclic ring		alcohol	thio ketone	thio ether	s-heterocyclic ketone			

### TABLE III

Functional Group								
Oxime	ester	pyridine	n-aromatic	chlorate	chlorine	Sp <sup>2</sup> -N	diazo	thioketone cyano
Nitrile	ciano	amine	aniline	bromine	amide	alkane	carboxylic acid	chlorine n-heterocyclic
Diazo								
Nitro	amide	carboxylic acid	amine	metals	thioether	sulfate	alcohol	
S-heterocyclic ring	aromatic	alkene	amine	chlorine	BF <sub>4</sub>	sulfate	ester	ether
Thiophene	SO	CO						
N-heterocyclic ring	aromatic	alkene	amine	chlorine	BF <sub>4</sub>	sulfate	ester	ether
O-heterocyclic ring	aromatic	alkene	amine	chlorine	BF <sub>4</sub>	sulfate	ester	ether



### TABLE III

Functional Group										
Oxime	n-oxide	ketone	aldehyde	carboxylic acid	bromine	aromatic	pyridine	BF <sub>4</sub>		
Nitrile	aromatic	potassium	aldehyde	thioether	pyridine	n-aromatic	bromine	ether	s-aromatic	
Diazo										
Nitro										
S-heterocyclic ring	amide	iodine	carboxylic acid	sodium	cyano	chloride	furan			
Thiophene										
N-heterocyclic ring	amide	iodine	carboxylic acid	sodium	cyano	chloride	aldehyde			
O-heterocyclic ring	amide	iodine	carboxylic acid	sodium	cyano	chloride	aldehyde			



TABLE III

Functional Group									
Oxime									
Nitrile									
Diazo									
Nitro									
S-heterocyclic ring									
Thiophene									
N-heterocyclic ring									
O-heterocyclic ring									

TABLE III

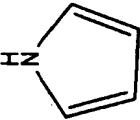
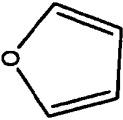
Functional Group	Functional Group Structure	Interacting Group				
Pyrrrole		chlorine	fluorine	amide	ketone	NO
Furan		s-heterocyclic				

TABLE III

Functional Group										
Pyrrole	SO	CO	imidazole	pyridine	n-aromatic	aldehyde	carboxylic acid	sulfate	chlorine	
Furan										

TABLE III

Functional Group										
Pyrrole	bromine	oxime	alcohol	phenol	ester	ether				
Furan										

TABLE III

Functional Group											
Pyrrole											
Furan											

**TABLE III**

Functional Group										
Pyrrole										
Furan										



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